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LEARNING FROM EXPERIENCE.[1]

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When one says he has reached a certain conclusion from his experience, particularly if that experience has been prolonged and varied, he usually expects us to consider him an authority. Nothing, however, is more common than for one person to dispute the conclusions drawn from another's experience and to appeal to his own experience for counter-evidence. One who has listened to farmers, mechanics, and all sorts of *practical* men, each attempting to disprove the conclusions of another by appealing to his own experience, is forced to think that in some cases experience serves little else than to entrench a person more firmly in error. Note how dubious the physician looks when his patient claims to know from experience that certain things are good or bad for him. I take it, however, that most of those whom I am addressing would rather rely upon the evidence of the practical than the theoretical man. We take a good deal of satisfaction in the fact that Galileo settled by observation and experiment many questions which had been mooted for two thousand years, after the fashion of the dialectics of Plato and Aristotle. And I suppose that most of us have a notion that we are teaching the future citizen the art of learning something reliable from his experience. We cannot hope that the few facts learned in school will suffice for life, and so we aim to prepare the student to gather facts from his experience throughout life, and we like to think that the difference between the schooled and the unschooled person is that the former will be able to give more reliable testimony from his experiences. This I find has been the *aim* of all books on science teaching which have been written in the last century and a half, and this is the *professed* aim of every one of us to-day—but what is our practice? During the third of a century, in which I have been engaged in

[1]Abstract of address delivered before the Eastern Association of Chemistry Teachers, Boston, May 11, 1912.

teaching and observing the teaching of chemistry, there has been a constant increase in the attention given to chemical theory in high school instruction—a greater and greater refinement of chemical definitions and doctrine and a proportional decrease in the tendency to lead pupils to derive their knowledge from the experiences of life. The introduction of individual laboratory work on the part of the pupils has even accentuated this tendency rather than counteracted it. Laboratory experiments are performed with apparatus which suggests nothing found anywhere outside the laboratory and for purposes which obtain nowhere else. Meanwhile, the refinements of chemical doctrine which are supposed to be fundamental remind one of the Church Catechism —and one of these codes has about as much relation to life's problems as the other. The commissioner of education in this state (Massachusetts) has said:[2]

"All education seems to inherit a fundamental tendency toward the abstract, the relatively unreal, the bookish. The teaching of science has done something to correct this, but even here there seems to be a persistent disposition to wander out of the sunlight."

There is a rather strenuous attempt in some quarters to teach what is called *applications in chemistry*. I note how this association and the New York Chemistry Teachers' Club and other such organizations of chemistry teachers devote most of their meetings to excursions to chemical factories and the like, presumably in search of applications of chemical principles with which to enrich their teaching. I think, however, that many teachers have gone only so far as to use these applications to give concreteness to their teaching of principles—somewhat as a dictionary defines words and quoted phrases to show their application. Some teachers think that school and college are the places to teach fundamental principles only, leaving the applications to be found by the pupil, if he needs, in after life. And some scorn practical applications as savoring of vocation or trade. But those who test students in after-life know that the graduates from such instruction carry with them little understanding of either applications or principles. Some few teachers take the stand that the applications must be taught from the first for the sake of making the principles understandable, but with all of these classes the end in view is "grounding the student in

[2]Educational Review, Vol. 39, p. 13.

chemical doctrine." Now I contend that a knowledge of chemical theory is of secondary importance to the vast majority of high school pupils, but that a scientific study of their daily experiences is of the greatest importance to all students. I might further claim that if one is seeking a knowledge of chemical theory he will reach that end most surely by inverting the usual order of procedure. I hear someone saying, "You cannot teach application until you have first taught principles," and I reply, "You cannot teach principles until after you have taught applications—very many applications." The high school course might well be little else than application with a very incidental reference to principles. It should be a sort of organization of experiences, letting one throw light upon another according to Huxley's idea that science is merely organized common sense. Twenty years ago I wrote a book on this plan, but I had at that time an exaggerated idea of the availability of the inductive method for the instruction of the young. I now believe in giving large doses of information. We need not, I think, fear the "talking teacher." All great teachers have been conspicuous for that gift, and it is noticeable that they all have bristled with information which they had a passion for imparting to others. Their pupils learned to think in orderly fashion apparently by imitating their teacher. It is a powerful incentive to scientific thinking to have a master, whom you fully trust, lead you through the interpretation of your own experiences. Our experiences and our observations upon nature are not naturally differentiated under such headings as chemistry, physics, physiology, botany, etc. If we label them anything we may use the term general science. It is *science* if it is organized common sense. By a strange inversion of ideas the college preparatory course in chemical doctrine has been called science. It seems to me to bear a similar relation to science that grammar does to literature and modern students go far in literature before touching grammar and they never study grammar much.

Let me illustrate my meaning by outlining some topics of instruction.

In front of a certain building there is an iron fence, very rusty, showing that some chemical action has been going on. There is another one near by which has been carefully attended to, scraped and painted, in order that this chemical action should not go on. We are at great pains, most of us, to see that this

action does not take place with our iron things. Many of our iron goods are covered with tin, zinc, or nickel to prevent this action. We cover them with vaseline. We oil them. We use agate iron, or enameled iron. Concrete covers iron in our modern buildings. It is so hard to prevent iron from this destruction that we do not expect to find pure iron in nature. If we want a pure specimen in a museum, we kept it free from the action of the air and free from contact with moisture. We have noticed that when iron is brought out of the blacksmith's furnace it has undergone this action much more abundantly; it is coated thickly with this rust. We have noticed in our experience that it will not do to let water stand in tin basins; we find a yellow spot where the water has begun to attack the iron through the tin. A hardware storekeeper will bring out his best cutlery, and unwrap it carefully protected from this chemical action, probably wrapped in something that will keep it dry and protect it from the action of the air. Nails which are left exposed to the weather go through this process, and they grow larger, a crust forms upon them, and they actually increase in weight.

I do not suppose that anybody will imagine that I condemn the teaching of chemical theory in its proper place. I am not urging that you follow the pace of the pupil, or even his interests. However, your students should draw from you the explanation and theory rather than for you to be forcing it upon them in the wrong place. I am contending that you do now put the chemical theory in the wrong place and furnish too much of it. Your pupils will want to know the explanation of this action, and you should tell the story of the modern idea of oxidation in a very brief and incidental way, and it should come up in many different connections if you would have it well understood.

Iron is not the only metal that corrodes. We have no end of trouble to keep our silver and brass from tarnishing. We protect them by covering with some metal which is less liable to tarnish. Your students will ask, why do silver spoons tarnish so rapidly in hard-cooked eggs? Why does a dime that is kept in a pocket with rubber eraser tarnish? Metals do tarnish; what are they given to uniting with? Look through a mineral cabinet and see what sort of compounds of the metal there are.

Heat seems to aid in this action, and heat carried to a much higher degree arrests the action. And so we can easily imagine the conditions of things outside of our experience. What about

the conditions in the atmosphere of the sun? We know something about the chemistry of the sun, almost as much as about the chemistry of our own surroundings. We have thus far noticed two influences which induce chemical change—heat and moisture. See how we make use of the first influence in the laboratory; nearly all our work depends upon the use of the Bunsen burner. There are very few experiments that do not require heat of some sort to produce the change desired. We cannot observe cooking processes very much without noticing that *time* as well as *temperature* is an important consideration. Why are we so interested in the fireless cooker? Largely because it brings in the question of time.

I remember how when I first became a teacher, I tried to bring out from the experiences of the country boy a series of lessons. We were burning a piece of paper and dropped it on the stove. It changed to a black substance, and a few drops of a thick liquid remained on the stove, smearing it. And I tried to make it clear by giving a multitude of other experiences. I will give you just an outline of this. I had been burning some waste paper in the furnace. When I opened the door of the furnace, drops of a thick liquid fell down from the inside of the door upon the paved cellar bottom. In that town I went to a country church which was heated by a stove, with a long pipe running the whole length of the building to a chimney. There were places where the stove pipe gapped, and oftentimes you could see drops of this liquid come out. Of course it was generally thought that it was water from outside that had come down the chimney. And then there was the smokehouse, where the same thing was going on over and over again, smearing the walls of the smokehouse. And then there were the chimney fires. Why should a pile of brick get on fire once in a while? I found that the inside walls were smeared with a liquid, and other things that came from the destructive distillation of what was being burned in the stove. Then there was the gas factory; because those were the days when they were throwing away the waste products. And when the long and interesting story of the coal tar products came out they created tremendous interest in my class in chemistry. And then there was the candle, and that most interesting book, "The Chemical History of a Candle," written by Faraday. He said in his introduction that in sitting down to watch that candle he saw every law of the physical uni-

verse illustrated. And then came the wonderful series of petroleum products.

Now heating breaks down chemical compounds, and it stimulates chemical action most interestingly in the springtime. What is going on in nature around us now? Why, there are two things; the rise in temperature and moisture. Where we have the two things together we get the tropical heat of summer, and we are not able to get along without using ice, and now we are about to begin employing the iceman again. Because nature is now stimulating chemical action, giving us the tropical conditions which stir up all sorts of chemical change.

But there is something else that comes from our observation regarding this; it is the reverse that chemical action is all the time tending to raise the temperature. I engaged a man to bring me some manure, which I intended to use on the lawn. It was dumped down in a heap and left there for a few days. One day when I was out walking with my son, we passed the pile of manure. He stopped me and remarked that the pile was steaming as though there was a fire in it. Well, of course, I had to give him a lesson in chemistry, though he was only eight years old. But he was just as ready to hear that then as he will be in the third year of high school. Later in the season, we mowed the lawn, and raked the grass into piles, and then we were negligent about removing it. My son, while playing on the lawn, put his foot into the pile of hay. It was very hot; the chemical action that was going on produced heat.

All along the street the plasterers are adding cold water to cold lime, making a mortar, and the whole gets steaming hot, and it is just sickening to see school children going by without seeing it. The trouble is they are tired of being snubbed for trying to learn from their experiences. What are all these regulations about disposing of painters' rags, etc.? They will produce heat and spontaneous combustion it is feared. To avoid such fires we are told that we must guard against heat and moisture.

But this thing is going on in our own bodies. Animal heat is simply due to chemical changes like the heat in the grass pile, and we succeed in keeping a very interesting balance between the cold of winter and the intense heat of summer. We go into a cold room and creep into so-called "warm" blankets, although they are not any warmer than the room itself. It is simply the making of the blankets warm by the heat of the body. Vegetable

life goes through the same process. We have, therefore, a tremendously interesting chemical action going on in all sorts of plant organisms.

So we are not surprised to find the sign, "Keep in a cool, dry place," upon packages of various things.

Then there is another thing that comes to a pupil from his experiences. That is that light is also an agent in the bringing about of chemical changes as, for instance,, in photography. I took up photography before there was any such thing as the dry plate, or the kodak films, or instantaneous exposure. I remember how I would go out three hours after sunrise and make an exposure for a certain length of time, to get a picture, and then go out in the afternoon three hours before sunset, and it would be necessary to expose the film about three times as long as before in order to get the same result, when no one could discover by any observation of the eye that the day was less bright. This set a whole train of thoughts going; and it was not long after this that I heard of the wonderful flowers in Norway, and the short season for growing wheat in Siberia, which is explained by the fact that the very intense heat is able to make up for the short season of high temperature. Then there were the sprouts growing upon potatoes in the cellar, and when you get them out in the sun they become green, because the chloryphyll in the plant is developed by the sun. Then there was the strange action upon our skins in the summer time, making the skin tan; and the fading of fabrics which we exposed to the light, and on the wall paper where pictures have hung. I recollect one summer we hung some pictures on the bare walls of a camp. Next summer we wanted to change the decorations and so took down the pictures. The spots showed very clearly where the raw spruce boards had not been exposed to the light, while the rest had grown very yellow. I remember a blue serge suit. After a few weeks wear I had occasion to turn up the collar of the coat, and there was the original color under the collar, while the rest of the coat was entirely different. When my sister took down her hair, there were places where it had faded, because of the action of the light upon it.

I see that my time has gone, and I won't try to suggest any more of this except to say that there is little in the whole field of science which you can teach to these young pupils except through the channels of their experiences.

SOME EXPERIMENTS WITH VIBRATING STRINGS.

By J. S. Shearer,
Cornell University.

The well-known Melde experiments showing to the eye the form of vibration of strings is usually performed with light cords or threads and show only simple plane polarized vibrations. For many reasons it is well to impress upon the student the fundamental relations between frequency, wave length and velocity and to show clearly that various wave lengths may exist at the same time either in simple progressive or in so-called stationary wave systems.

A simple device (Fig. 1) for giving a rotary excitation to a string without twisting it has been in use in our lectures for

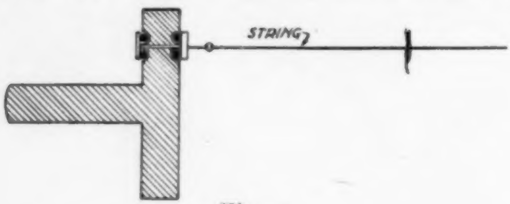


Fig. 1

some time. It consists of a pin free to twist in ball bearings and mounted in a disk rotated by a motor. A string of convenient length (10 to 50 feet) may be attached at one end and the other end either held in the hand or fastened with any desired tension. At constant speed with variable tension a great variety of wave lengths may be shown. At constant tension and variable speed the same series come out and show the unstable state of transition from one form to the next.

If two motors are available, a different frequency may be impressed on *each* end showing a composite wave form. When the string, driven at one end, is held at 45° to the axis of rotation a double frequency wave is shown often with a slow rotation. Any of these waves may be plane polarized by a slit held near a node. By using two slits at right angles, we have along part of the string a wave of complex type, along the region between the slits a plane polarized wave and no disturbance along the remainder. The selective action of a system for waves of its own frequency may be shown by making a triangle (Fig. 2) of string under tension having the sides unequal in length and attaching the end of the vibrating string to one corner. On varying the frequency one or more sides

of the triangle will spring into vibration when the "tuning" is correct.

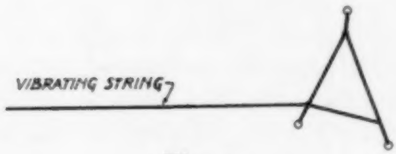


Fig. 2.

The relations between tension, mass per unit length, frequency and wave length may be shown in various ways. If two cords of quite different weights per foot are tied together it is possible to adjust the tension so as to bring a node at the

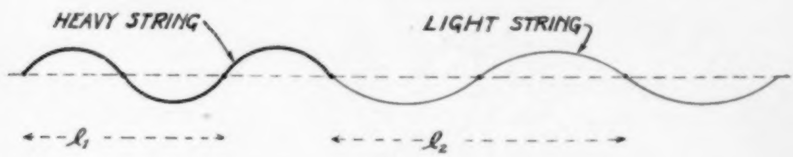


Fig. 3

junction. Since the *frequencies* are the same and the velocities of wave propagation and wave lengths are different, we have

$$V_1 = nl_1,\ V_2 = nl_2$$

hence $$V_1/V_2 = l_1/l_2 = \frac{\sqrt{T/m_1}}{\sqrt{T/m_2}}$$

and $$\frac{l_1}{l_2} = \sqrt{m_2/m_1}$$

[v=wave velocity
n=frequency
l=wave length

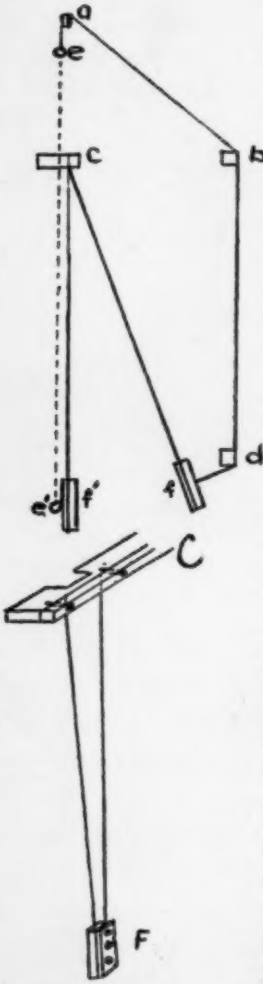
Another instructive experiment may be shown by using a long spiral spring (Fig. 4) suspended vertically and driven by a rotor turning about a vertical axis. The upper portion of the spring is under greater tension than the lower and on account of stretch has less material per unit length. For both these reasons the wave velocity in the upper portion exceeds that below and gives a *longer wave* for the same frequency. It is quite easy to get the upper nodes two or three times as far apart as the lower. Other experiments may be shown and quantitative relations are easily worked out.

FIG. 4.

A SIMPLE APPARATUS FOR DETERMINING THE ACCELERATION OF A FREELY FALLING BODY.

By W. M. Parker,
East Side High School, Denver, Colo.

This apparatus was devised after unsuccessful attempts to get satisfactory results by use of a wooden bar as the pendulum. A metal block (*f*) (about 10 cm. x 5 cm. x 3 cm.) is suspended by two fine annealed steel wires to a rigid support (*c*). A thread is attached to a hook on the center of the back of the block and passes under a support (*d*) so placed that the thread is perpendicular to the face of the block when the pendulum is drawn back through a small arc. The thread then passes upward over supports (*b*) and (*a*) and is attached to a metal ball of sufficient weight to retain the pendulum in its deflected position. The support (*a*) is accurately adjusted so that the plane of the face of the block is tangent to the ball when the pendulum and ball are hanging freely at rest. This was accomplished in the case of this particular apparatus by suspending the ball and pendulum freely as (*c'*) (*f'*) and cutting out the notch in support (*a*) until the ball just touched the face of the block. A piece of carbon paper and a piece of white paper for the record are fastened to the face of the block by rubber bands. The thread is cut just above support (*b*) releasing the ball and pendulum at the same time and avoiding retardation due to the thread dragging on the supports. The pupil is told the approximate starting place of the ball in order that it may strike the block for that particular length of pendulum. The distance from the center of the ball at rest to the dot on the record paper is measured to mm. The time of fall, being one half the period of vibration of the pendulum, can



be found with any desired degree of accuracy. It has been our practice to time from 50 to 100 vibrations by means of a stop watch or an ordinary watch that has a large second dial. By this means the error in the time of fall is less than .01 sec.

This apparatus has been in use in our laboratory for three years and with reasonable care on the part of the pupil can be depended upon to give a value of g to within one per cent. Of course the pendulum and ball supports must be very rigid. An electrical release has been tried, but we returned to the form described here because of its simplicity and reliability. This method for finding the acceleration of a freely falling body has the advantage of being simple, direct, and accurate.

Trial	Number of Vibrations	Time in Sec.	Time ½ Vib.	Distance Body Falls
1	50	61.4 Sec.	0.614 Sec.	184.5 cm.
2	50	61.6 Sec.	0.616 Sec.	184.8 cm.
3	50	61.4 Sec.	0.614 Sec.	186.6 cm.
Mean	50	61.46 Sec.	0.6146 Sec.	185.3 cm.

Length of pendulum 150.4 cm. Value of g 983 $\frac{\text{cm}}{\text{sec.}^2}$

METHODS OF ILLUSTRATING CRYSTALLIZATION.

By J. E. Stannard,
Adelphi Academy, Brooklyn, N. Y.

I lay no claim to originality in what I have to present on this subject. I have simply brought together a few ways of illustrating an interesting property of matter that often receives very little attention. Crystallization is not an important topic, but it is one that can be attractively illustrated and we need to present such topics once in a while, even though they may not be mentioned in the syllabus, just by way of giving a spicy seasoning to the regular course.

Realizing that something which the student can see and perhaps handle will always make a more lasting impression on his mind, I would present this subject with few words but many illustrations. First, large well-formed crystals may be shown. Beautiful large crystals of copper sulphate may be obtained, and if kept under a glass receiver, tightly sealed, they will last for

a long time. Some metals, as zinc, cadmium, and bismuth, form crystals that are large enough to be seen by a class.

A saturated solution of ordinary salt may be made a few days beforehand. This may be colored and forms an effective illustration after the salt crystals have crept up over the edge of the dish. Some well-formed cubical crystals will be found floating on the surface of the liquid if the dish has stood in a quiet place. Threads suspended in hot saturated solutions of alum and copper sulphate will produce very regular-shaped crystals of good size.

A saturated solution of potassium bichromate may be poured over a glass plate of lantern slide size and this put in a quiet place over night. This may be used for projection with the lantern.

A supersaturated solution of sodium sulphate may be prepared by dissolving in hot water all the salt the water will take, and putting this in a *quiet* place to cool. Rapid crystallization may be produced by shaking or dropping in a crystal of sodium sulphate.

If you can find opportunity for the student to work on the subject in the laboratory, here are a few simple experiments he can do:

1. Melt potassium bichromate in a hard glass test-tube. Roll the tube so that the liquid wets the surface well. Watch the formation of crystals as it cools.

2. Make a hot saturated solution of potassium nitrate. Crystals can be seen forming as it cools.

3. Make in test-tube a hot saturated solution of ammonium chloride. Set aside until next laboratory period. Beautiful crystals in the shape of Christmas trees will be formed, extending from the bottom up and from the surface down into the solution.

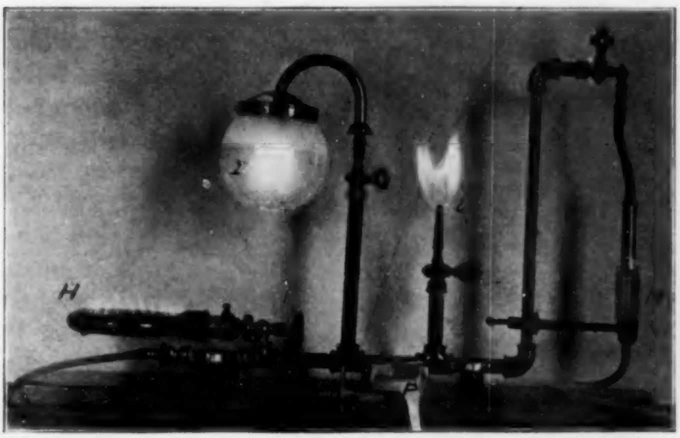
In the lecture room this subject offers an excellent opportunity to use the microscope projection apparatus. Drops of various solutions may be put on the small glass plates used and as the solution dries the formation of crystals may be seen on the screen. Solutions of urea, salicylic acid, and ammonium chloride give good results.

By using a polarizer and analyzer and specially prepared microscope slides very interesting and beautiful color effects may be produced when the analyzer is rotated. Slides with potassium sulphate, nickel and potassium sulphate, sugar, and salicin give excellent results. Plain slides with drops of the solution put on may be used, but the prepared slides are more satisfactory.

A TEST OF GAS BURNERS.

By H. W. Harmon,
Grove City College.

The apparatus shown in the cut was designed and the experiment was planned especially in the interests of the girl members of our physics laboratory sections. The cut shows the apparatus with several burners in operation. The gas enters and passes through the Thorp gage or gas meter (M), which is direct reading. The apparatus has a base 15x70 cms., and stands 40 cms.



high. It is made of three eighth inch gas pipe. Other burners are easily exchanged for those shown.

The burners are turned on separately and are regulated so that the quantity of gas flowing through them is measured by the meter as the burner is turned as high as it would ordinarily be used, and when as low as it would burn. The cost is then calculated from the results obtained. A scrutiny of the results is interesting: the advantage of the inverted mantle over the upright form is noticeable in the cost, 59 cts., compared with 83 cts. per month. The lava-tip burner uses about twice the amount of gas and yet gives only about one-fifth the amount of light that the mantle burner does. The hot-plate and hot-water heater burners use about the same amount of gas and cost $1.89 per month to run at full flame. The gas stove about one half more.

Various questions might be asked: Would it be cheaper to dim a mantle burner during the day rather than turn it out, with the danger of breaking the mantle plus the cost of the match? What

would it cost for gas to cook a dinner using three hot-plate burners for three hours? Etc.

This is a popular experiment with our students, boys as well as girls:

Trial	Kind of Burner	Height of Flame	Gas Burned per Hour	Cost per Hour @ 25 cts. per 1,000 cu. ft.	Cost per Day	Cost per Month
1	Lava Tip or Fish Tail	High	5.0 cu. ft.	.125 cents	3.00 cents	$ .90
2		Low	1.0 "	.025 "	.60 "	.18
3	Inverted Welsbach Mantle	High	3.25 "	.081 "	1.95 "	.59
4		Low	1.75 "	.045 "	1.08 "	.32
5	Upright Mantle	High	4.50 "	.113 "	2.72 "	.83
6		Low	1.50 "	.038 "	.92 "	.28
7	Bunsen Burner	High	6.50 "	.163 "	3.92 "	1.18
8		Low	1.50 "	.038 "	.92 "	.28
9	Hot Water Boiler	High	10.50 "	.263 "	6.30 "	1.89
10		Low	2.00 "	.050 "	1.20 "	.36
11	Hot Plate	High	10.50 "	.263 "	6.30 "	1.89
12		Low	2.00 "	.050 "	1.20 "	.36
13	Gas Stove 12 Tips	High	15.00 "	.375 "	9.00 "	2.70
14		Low	5.00 "	.125 "	3.00 "	.90

THE PART OF ASPHALT IN GOOD ROAD-MAKING.

In the original Bible the same word is used for salt and for oil or asphalt—because both came from springs, and both are obtained from the Dead Sea, and when asphaltic oil is substituted for salt in the well-known quotation, "If the salt (oil) have lost his savor (volatile portion) wherewith shall it be salted? it is thenceforth good for nothing (asphalt) but to be cast out and to be trodden under foot of men." This sounds prophetic in view of the thousands of miles of asphalt pavements in modern cities. Far more important, however, is the use, now in its infancy but rapidly increasing, of asphaltic oils for sprinkling over macadam roads to prevent dust and obviate the damage done by rapidly moving automobiles in tearing out the surface. The Secretary of Agriculture, in his address to the first National Good Roads Congress, mentioned this treatment as solving the important problem of rapid automobiling over macadam roads.

Four kinds of asphaltic oils are now prepared for this special purpose by taking the volatile matter out of Texas oils and other similar asphaltic oils, until the residue contains 30 to 60 per cent of asphalt, the product according with the requirements.

VISUALIZING OSCILLATIONS BY MEANS OF A USEFUL AND INTERESTING LECTURE TABLE APPARATUS.

By Charles F. Bowen,
Manchester, N. H.

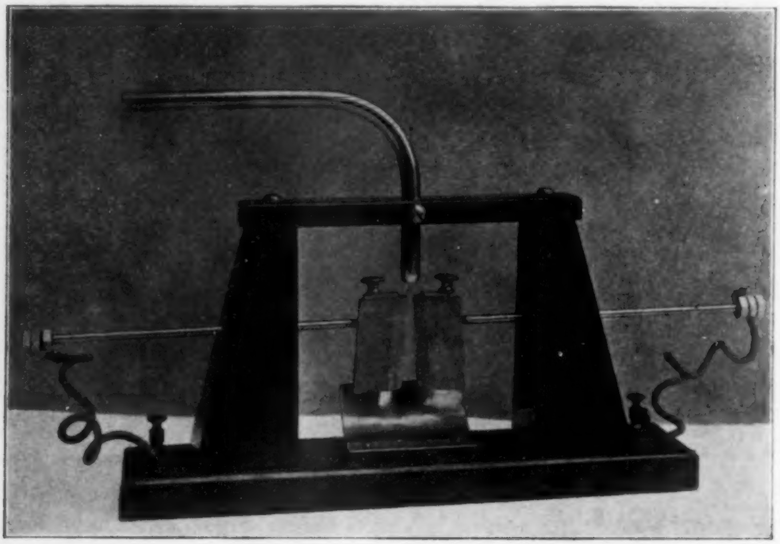
Many teachers of physics experience considerable difficulty in explaining and proving the oscillatory character of the disruptive discharge of an electric condenser. While it is possible to deduce the interval $T=2\pi\sqrt{LC}$ in such a manner that the train of reasoning can be followed easily by an ordinary high school pupil, or, by agency of the Faraday tubes of electrostatic induction give a fairly concrete conception of the precise mechanical disturbance that occurs—these are, nevertheless, unsatisfactory methods. The mind of the average student is not sufficiently mathematical to subsist on these abstract sketches; he requires an experimental proof.

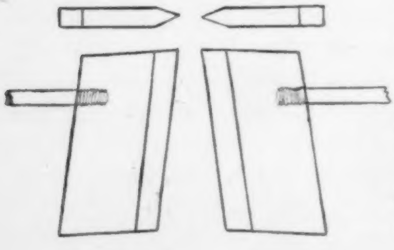
Unfortunately, a demonstration sufficiently simple for the lecture table and yet conclusive in its evidence, has not been at hand. Professor Q. Majorana, in connection with his experiments with very rapid sparking, devised an interesting method of separating the sparks. Two gaps were arranged in parallel, with electrodes arranged so as to take advantage of the superior facility with which a discharge begins at a point. But, beautiful and instructive as this method is for currents of comparatively low frequency, when the periodicity becomes excessively high it cannot easily be applied.

Professor Henry's method of observation, in 1842, of the anomalous magnetization of a steel needle when placed within a solenoid through which a condenser discharge is passing has sometimes been employed, but this experiment requires the insight of a Henry and a gifted imagination in order to be able to discern the true state of affairs. Fedderson, in 1857, arranged to view the discharge by agency of rapidly-revolving mirrors, but this method has practical objections, and, for another matter, is not always intelligible to the student. Nor can methods based upon photography be employed on account of the necessity for deferring the evidence until the film or plate can be developed and also on account of the mechanical complication involved. The average science teacher has no time to arrange a mass of apparatus for his lectures, so that a simple piece of apparatus is a great desideratum.

The writer, in particular, has felt the need of such a piece of apparatus. The bulk of his work has been in connection with currents of high frequency and high potential, so that mechanical models and visual demonstrations of one kind and another became an absolute necessity. A variety of different devices were worked up for the purpose of making visible the surging discharge of a condenser; some of them having been described in various technical journals. But the little device illustrated and described herewith has given the most satisfactory results.

The method is based on the well-known faculty of the blast-pipe to separate successive electric sparks, so beautifully treated by Dr. Hemsalech. It has been used by the author for the past two years and has proved of the utmost utility. With the hope that other science teachers may find time to build such a deflagrator, some details in regard to construction will be given.





The device proper consists of a strong frame as shown, with a ⅜ inch hole in the crossbar to admit the curved blast pipe. Through each of the posts, about half way up, is pierced a 3-16 inch hole accommodating a tightly-fitting

glass tube through which runs brass rod, threaded at both ends. One end of this is screwed into a wedge-shaped copper electrode of the form shown. On the other end of the rod are screwed two nuts which served as binding posts. Copper washers should be fitted between these.

On top of each of the electrodes is a small brass plate which is so arranged that it may be tightly pressed against the top of the electrode. The whole system is lined up so that the rods are in a straight line and the wedges directly opposed and at the same height. Small pieces of platinum wire such as may be procured from a burned-out incandescent electric lamp, are clamped under the brass plates on top of the electrodes, in such a manner that they project slightly beyond the wedge-edge. The blast pipe should be positioned about five or six millimeters above the line connecting the platinum wires, depending upon the size of the orifice, which will be found to be best at about two and one-half or three millimeters. The angle of inclination of the wedge-edges is an empirical matter. All these things—the length of the gap, the strength of the blast, the height of the orifice above the gap, etc., can be readily adjusted, depending as they do upon local conditions. A curved brass shield as shown may be placed upon the base block to deflect the blast and thereby save the eyes of the operator from dust and metallic particles, and the wires from the ends of the rods may be led to regulation binding posts on the base.

This peculiar gap is then connected in series with a suitable condenser and inertia coil. The condenser may be one or two microfarads, if a good-sized laboratory induction coil be used to charge it, and it should be a glass or oil condenser. The capacity for a regular plate condenser can readily be computed from the well-known formula $C = \frac{885Ka}{10^{10}d}$, where K is the inductivity of the dielectric between the plates, *a* the area in square inches of all the "sheets" of dielectric between the metal plates and *d* the thickness in inches of the dielectric leaves. The inductance coil should be wound upon a fiber tube or upon a wooden frame and should be of such value as to make the oscillations have a frequency of about 25,000 or 30,000. By means of a sliding clip the inductance and hence the frequency may be varied. This coil should be so made as to permit of the use of cores of various materials.

The writer finds it convenient to make use of a half-kilowatt loosely-coupled resonance transformer and thereby not only gains the advantage of a great many discharges per second but also the greater power and the exalting effect of the resonance arrangement. An ordinary ten-inch induction coil will, however, give marked effects.

If now a source of air pressure of sixty to eighty pounds be connected to the blast pipe and the transformer or inductorium started—upon properly adjusting the pipe, the blast and the electrodes, the discharge will spread out down along the gap and one can count as many as ten or a dozen distinct oscillations. The effect is due, of course, to the movement of the bridge of ionized air formed by the passage of the initial spark. Usually but five or six bands will appear perfectly motionless and plain, the others being irregular and variable. Arrangements may be made to view the phenomenon by means of a magnifying glass or by taking a little time the display may be projected upon a screen for the benefit of an entire audience.

All the interesting experiments described by Dr. Hemsalech may now be tried. The effect upon the bands of the introduction of various cores is a simple one. If a thin tube of iron be introduced into the inductance coil, it will be found to destroy nearly all the oscillations, without very much affecting the frequency, an effect due to the Foucault currents and the hysteresis of the iron. If instead of a continuous tube a bundle of iron wires, insulated one from the other, be used, the frequency will be diminished but the intensity will remain unchanged, this being an effect due solely to hysteresis.

If a zinc tube be used, the frequency will increase, owing to lessening of the self-induction of the coil (another effect of the Foucault currents), though the intensity is not changed. If the zinc tube be split, the Foucault currents will be suppressed. If a split iron tube be used, the oscillations will be greatly reduced in intensity and the frequency will be somewhat reduced. If, while this condition prevails, the zinc tube be slipped on over the iron tube, the oscillations are at once strengthened and their frequency considerably increased, due to the presence of Foucault currents. This is a striking demonstration of the phenomenon of the "skin effect."

Many other interesting and instructive experiments can be worked up by the teacher, such as the determination of the

approximate velocity of the particles of nitrogen which carry the electric current, by observation of the angle which the direction of the oscillations makes with that of the blast. Hemsalech used frequencies of 27,400 per second and found this velocity to be about 29 meters per second. It diminished as the capacity of the condenser increases and is directly proportional to the frequency of the oscillations. Hemsalech used a blast velocity of 36 meters; the author has been very successful with one slightly greater.

An interesting fact in this connection is that the velocity of the oscillations is less than that of the initial discharge for the latter is a straight line between the platinum wires, while the others are curved paths. Upon spectroscopic examination it is found that the initial discharge gives the "line" spectrum of air while the oscillations give the "band" spectrum of nitrogen. With the electrodes used, the metallic vapor appeared to play no part in the conduction of the current.

If it is not convenient to use air under pressure, either from a pump or a foot bellows and tank, carbon dioxide gas may be used. This may be procured in tubes to pressures as high as 5,000 pounds per square inch. If used at such pressures it will be very "wet," and it will be found best to let some of it out into another tank at about a hundred and eighty or two hundred pounds and use this instead of the greater pressure. The tube of carbonic acid gas will be found convenient in classes in heat and chemistry. One may produce carbon dioxide snow and by use of ether freeze mercury in a test tube.

The possessor of a device of the kind described in this article will find it of great value. With the present wholesale introduction of high frequency currents in radio-telegraphy and radio-telephony and in medical work, more time must needs be given the discussion and illucidation of rapid electric oscillations. In connection with a small wireless outfit, and a singing arc, all of which could be constructed by an ingenious teacher for a few dollars or purchased in the market for scarcely more than $5, this blast-gap forms a set of lecture table apparatus which can be used to explain and exhibit all the later developments in high frequency work and in the various methods of communicating signals and audible speech without the use of wires.

THE FUNCTION OF CHEMISTRY IN THE MODERN HIGH SCHOOL.[1]

By W. J. Bray,
Normal School, Kirksville, Mo.

The more familiar one becomes with the manner in which chemistry is taught in the average high school, the more one is impressed with the idea that there is not a proper appreciation of the real function of elementary chemistry on the part of those who are teaching the subject. If I can stimulate some new interest and thought along this line that will lead to more rational teaching of this subject in secondary schools, I shall be gratified, indeed. Too often this subject is not taught from the standpoint of the pupil at all. His needs appear not to be taken into any serious consideration in outlining the content of the course. If we can teach our pupils, I am inclined to think the subject-matter will take care of itself. Too often we teach the subject, merely, losing sight of the real function of the subject-matter in the life of the pupils. Chemistry must be a real live subject in the curriculum, filling a real need, or else give way to some subject that does meet these requirements. One of the most important facts of modern times is what has been called the marriage of science and industry, and yet, we find chemistry teachers who apparently have never heard of this fact. They teach the subject very much the same as it was taught long before this "marriage" took place. I believe that chemistry has no place in the curriculum of the average high school, unless it be planned and taught as a practical subject, having a very vital relation to everyday life, and to other sciences.

Although chemistry, strictly speaking, is by no means the oldest science, it has certain elements in it which serve as the explanatory connecting links between physics, physiography, biology, agriculture, and domestic science. The teacher who fails to take this fact into account in his teaching of chemistry is losing his best opportunity to make his course count for the most in the lives of his pupils. It is far from my purpose to detract from chemistry as an independent science. On the contrary, that science is most truly worth while which forms the greatest number of contacts with our daily life, and aids most in the solution of the problems of life.

[1]Read before the Science Section of the Missouri Society of Science and Mathematics Teachers November 9, 1911.

The chemistry in the high school is called upon to meet a variety of conditions and needs. Scarcely five per cent of our high school pupils enter college or university, some become teachers, but a great majority of them will go into affairs of business or professional life. To this last class formal chemistry cannot be of much use except as it enables one to reason more clearly about the causes of physical phenomena, and to form the habit of getting at the bottom of things in a systematic way. The course should be planned with the needs of the majority distinctly in view. If it be necessary—which I seriously doubt—for any class to be left out of primary consideration in the outlining of a course in elementary chemistry, let it be those pupils who will have the opportunity to make up any deficiency which might have been caused thereby, in their college course. We too often seem to ask ourselves, will this course properly prepare my pupils for college, when the question should be, will this course do all that it might do to prepare my pupils for life? I think I am not lacking in appreciation of the more theoretical side of chemical instruction, but so many teachers do not strike the proper balance between the theoretical and the practical. The teacher, absorbed in the intrinsic interest of the subject itself, fails to appreciate his pupils' point of view. For the pupil the subject has value and interest in so far as it aids him in the solution of the problems that he meets in his daily life, and in the understanding of the civilization in which he lives. Out of the vast mass of subject-matter which might be included in a course elementary chemistry, we must select those laws and theories which fundamentally underlie the subject, and, preceding them by experimental data, assist the pupils to master them at such time as they are best prepared to take up such laws and theories without confusion. Whenever we have the choice between some nonessential theoretical matter and those things which pertain to the practical application of the science to the problems of everyday life, I see no reason why we should hesitate to choose the latter. I should have the pupils well grounded in the fundamentals of the science, but it seems to me that many teachers "go to seed" on theoretical chemistry in the high school. It is possible that the college professor might prefer to have his pupils coming from high school thoroughly versed in the Phase Rule, the Law of Mass Action, radioactivity, the electron theory, and the like, but should we not consider the vast majority of our pupils for whom such things can never be more than a bugbear soon to be for-

gotten, if, in fact, they are ever learned. Should we not remember that probably ninety-five per cent of our pupils will never have another opportunity to learn the relation of the science of chemistry to the things he will have to do with in after-life?

If we are to accomplish the greatest good, we should carefully avoid either of the extremes. It is of the greatest importance that the pupils be made as thoroughly familiar as possible with the elements of the science. We should not, however, neglect the application of these facts along the line of greatest benefit to the greatest number of pupils. We must make the course meet the needs and interests of the class. Too often our courses are cut and dried affairs with no elasticity to meet the varying needs and interests of the various classes of pupils. Girls are forced to plod over the same things that boys delight in. Courses are not varied to meet the needs of the community. The course in a rural high is often identical with that of the city school. No teacher ought to feel himself bound by any text-book to adhere rigidly to any particular line. The teacher who is properly equipped for his work will always make the course fit the needs and conditions of his class. The real trouble in this respect is that often the teacher's preparation to teach the subject has been so inadequate that he cannot make himself independent of his text-book. Text-books are written along general lines to meet a multitude of varying conditions. The skillful teacher will teach the subject and not the text—and I am not intending to cast any reflection upon any text-book writers in saying this. It is gratifying, however, to notice the growing tendency on the part of authors to maintain a proper balance between the theoretical and the practical phases of chemistry by increasing the stress on the latter in elementary work.

There are various means which the teacher can use to assist in bringing chemistry to assume its proper place in the high school. A brief discussion of a few of these may not be out of place here.

One of the best means of bringing the class into a vital touch with the applications of chemistry in everyday life is the stereopticon. Every high school should be equipped with a good instrument of this kind, and a good collection of slides on manufacturing and mining processes, men of science and industry, metallurgy, etc. One should find this plan to give the class a rapidly increasing interest in the subject, because it gives them something that connects the pure science with what has already

become a part of their conscious experience and in which they have already an active interest.

In connection with the study of nitrogen, phosphorus, or potassium, those who are interested in agriculture might profitably be shown how to make some simple soil tests for these elements which are so essential to plant life. From that they could be permitted to go into a brief study of fertilizers in general from the standpoint of chemistry. The great nitrogen problem should be studied in some detail, and its final solution by the fixation of atmospheric nitrogen in the form of calcium cyanamide pointed out. They should study about the great phosphate deposits of Florida and elsewhere, and how those phosphates are handled and made into fertilizer. It might not be out of place to call the attention of the class to the fact that a very large per cent of this fertilizer in the form of calcium phosphate mined in the United States is shipped directly to Europe, where it is made into the soluble superphosphate of lime and shipped back again for us to use. I am inclined to think that a little education along this line might be a good thing for our country.

The teacher should make a special study of the manufacture of matches. He should point out the terrible diseases to which the employees in factories making the phosphorus match are constantly exposed. He should point out that, in spite of our boasted civilization, the United States is the last of the great civilized nations of the world to outlaw the poisonous phosphorus match. The teacher can be a powerful factor in bringing about this much-needed reform, by educating the coming generation to the proper uses of this element.

No teacher of chemistry can afford to pass over the chapter on water without devoting considerable time to the practical problems of water purification and sanitation in general. The pupils will be delighted to learn how to test for those substances which make water unsuitable for use. They should learn how hardness of water and alkalinity of water effect railroads and other industries using steam engines, and how their problems are solved by chemistry.

Time should be taken to study foods in a general elementary way. Professor Olsen's new book on "Pure Foods" should be in the hands of every teacher of chemistry, and in every high school library. Following some such work as that above named, a class could very profitably spend some time in making some simple tests of foods for their purity, and in studying the great

problem of pure foods. The teacher should see to it that the name of Dr. Harvey W. Wiley is a household word in this country, standing out as the champion of the people in the fight against impure and adulterated foods. These things are certainly of greater benefit to the pupils than a study of some of the laws and theories more remotely connected with elementary chemistry or with everyday life. This work should appeal especially to the girls, and if they should happen not to have the opportunity to take a course in domestic science, I think I should permit them to spend extra time on this topic even at the expense of some other work that the boys might be required to do. Whether domestic science is in the course of study or not this phase of the course cannot properly be neglected in this connection. Every pupil in elementary chemistry should know the common means of adulterating foods, and how to recognize such adulterants. They should know something of the conditions under which the most dangerous ptomains and proteid toxins are formed, and how they may best be avoided.

In this connection it would be profitable to study the chemistry involved in some of the simple processes of cookery, such as the cooking of meats, the baking of bread, etc. The teacher might profitably lead the class in tracing the chemical history of bread, the transformation of starch into dextrine and into glucose, the manufacture of alcohol from grain, etc.

The teacher of chemistry has an opportunity to exert an influence along the line of conservation of resources and utilization of waste products that is by no means negligible. The class would be interested to know how chips, brush, sawdust, and other waste wood may be made into alcohol. Few of them have ever dreamed that even cornstalks, weeds, and such things may be made into alcohol, not for beverage purposes, but as denatured alcohol, tax-free, to be used in a variety of ways in the industries and arts. It is rapidly taking the place of wood alcohol in all manufacturing plants, because it is cheap, and because the latter has a very marked tendency to cause a permanent blindness in the employees using it every day. They will delight to read in Duncan's "Commercial Chemistry" the chapter on industrial alcohol and its wonderful possibilities. They will be interested to know that, according to present indications, industrial alcohol is destined to displace gasoline in practically all of its important commercial uses. The time is not far distant when the farmer

can make his own alcohol, tax-free, with which to run his engines, automobiles, etc., much cheaper than he can buy gasoline now.

Chemistry may be correlated with physiology in an elementary way by studying something of the chemistry involved in such physiological processes as digestion. This can be easily adapted to an elementary class, and can be made both interesting and instructive.

A few simple experiments on dyeing may be advantageously introduced. Such experiments are easily performed, take very little time, and help to drive home a very important application of chemistry.

Without any expensive apparatus, some simple assays of ores can be made illustrating important metallurgical processes in such a way as to carry an added interest into the work.

It is good for a pupil beginning chemistry to feel that he is on terra firma most of the time at least. Such results can be obtained only when we bring him up to the subject by bringing the subject down to him in as many ways and in as many places as possible not to lose sight of our general upward direction.

One of the surest ways of getting a pupil to get the full benefit of a course is to arouse in him an active interest in the subject, and, conversely, one of the surest ways of killing a subject, so far as its usefulness is concerned, is to allow it to become so technical as to become uninteresting to the class. Any device which the teacher can use, without sacrificing some important fundamental principle, to add interest and show the subject-matter to bear a vital relation to the problems of life will help to bring chemistry to perform its proper function in the high school. If, in attempting to follow some such scheme as I have outlined, it is found necessary to eliminate some matter of less consequence, I should say cut out the thing of lesser consequence, but be judicious in doing so. Such a plan as this will not necessitate the purchase of expensive apparatus, but will necessitate the teacher's being prepared for the work. In addition to college courses in the subject, he should have some good reference works at his command. Such books as Thorpe's "Industrial Chemistry," Duncan's "Commercial Chemistry," Olsen's "Pure Foods," Snyder's "Chemistry of Plant and Animal Life," "Williams' "The Chemistry of Cookery," Johnston's "The Chemistry of Common Life," and as many good texts on the subject as he can get, are good. With such an equipment as this a high school course in chemistry

can be made to become one of the most, if, in fact, not the most, useful science in the entire curriculum. I would have chemistry always to be taught as being useful rather than ornamental. Its true function must be found, it seems to me, only in its presentation from a utilitarian standpoint. If, as under ideal conditions, it is possible for chemistry to follow physics, biology, and agriculture, and either follow or accompany domestic science, so much the better for the pupil. This course should serve, in a way, to unify them all. If not the course in chemistry can be so given as to throw light and information upon these other subjects even if chemistry should be the only science elected, provided the pupil does not elect this course below his junior year. In this way, and in this way only, I believe, can chemistry do its most to equip our pupils for the battles of life.

SULPHUR MINED BY PUMPING.

Seven or eight years ago the imports of Sicilian sulphur amounted to more than 100,000 long tons. With the growth of the sulphur industry in Louisiana, according to the United States *Geological Survey*, the imports of Sicilian sulphur in the United States have become almost a negligible quantity, the entire imports from Italy for 1910 being but 10,704 tons. The production of sulphur in the United States for 1910 was 255,534 tons, valued at $4,605,112, the great bulk of which came from Louisiana.

The mining of sulphur in Louisiana is an interesting process. The sulphur deposit, situated near Lake Charles, lies about 440 feet beneath the surface and is about 100 feet thick. Beds of quicksand overlying the sulphur render the sinking of shafts impossible, and the sulphur is therefore pumped to the surface. A well is driven through the numerous strata to the sulphur-impregnated beds, in much the same manner as is usual in sinking wells for oil and gas. In each well there are placed concentrically four lines of pipe, having diameters ranging from 10 inches to 1 inch. Superheated water and hot air are forced down the pipes and the spaces between them to melt the sulphur and to bring it to the surface. The hot water flows down between the two outer pipes, which are respectively 10 inches and 6 inches in diameter, and passes into the sulphur-bearing mass, melting the sulphur. The quantity of sulphur melted and the range of action of the water depend on the temperature of the water and on the pressure at which it is supplied. The heavy melted sulphur runs back into the pump around the bottom of the well pipe, which it enters through holes provided for this purpose. Hot compressed air is forced down through the smallest of 1-inch pipe and at the bottom of the well mixes with the melted sulphur and forms an aerated mass sufficiently low in specific gravity to allow the water pressure to elevate the melted sulphur to the surface, where it is discharged into large rectangular vats, constructed of rough planking. The dimensions of the vats vary somewhat, but they are made as large as 350 by 250 by 40 feet, and some of them are so arranged that railroad trains can pass between them. After the sulphur has cooled and solidified, it is regularly mined the same as if it were a natural deposit.

COMMUNAL CHEMISTRY.[1]

By Lewis B. Allyn,
State Normal School, Westfield, Mass.

Ten decades and more have passed since the introduction of chemistry into the curriculum of academy and college.

From earliest times one of the strong arguments in favor of the subject as a study for pupils has been the fact that it offers exceptional opportunity for the investigation of matter and affords a more or less vague kind of mental training. This latter was known as "culture" and like mathematics was supposed to train the general reasoning powers of the pupil. Modern research has quite disproved the theory of "culture" and sets aside the dogma of universal reasoning power.

It is safe to assert that in a large per cent of chemistry courses the instructor has looked for the results of his teaching in the immediate pupil. We shall attempt to prove that this aim falls far short of what the subject may be made to do.

In the twelfth chapter of Romans we read of "reasonable service." Chemistry in the hands of a pupil may be made to perform "reasonable service" outside the laboratory.

We would not in any way seem to adversely criticise the worthy pioneers of chemistry teaching nor attempt to detract from their well-earned honor. Without contumely we shall try to show that, however good chemistry for the pupil alone may have been, chemistry for the pupil and the community is better.

If the writer may be pardoned the reference, his introduction to chemistry first in the high school and later in the college gave him a fair degree of familiarity with the elements as then known, likewise their combinations and marks of differentiation. The analytical work consisted for the most part of the examination of the contents of sundry bottles labeled X, X1, X2, and the like. They contained material which everyone knew had been concocted by the instructor or selected from the laboratory by him. Pupils to-day call such samples, "dead stuff" and the name is not inappropriate. At any rate they had no living interest for the class. None of us suspected nor did the instructor remotely suggest that these bases and radicals which we were laboriously isolating were bone and sinew, part and parcel of the community in which we lived. It was distinctly the chemistry of the school-

[1]Read before the Science Section of the National Education Association, Chicago, July 11, 1912.

room and vague indeed were our ideas that these same sulphates and chlorides and nitrates and a score of other radicals made life not only happier but also possible; that some of them misplaced would hang out a danger signal that must not be lightly disregarded.

Not until the writer had been an instructor of chemistry for some years did it occur to him to supplement these same X's by sending the pupils out into the town and home to find where they were naturally met with and how they functioned in everyday life. Perhaps one of the most helpful suggestions of modern education is that which prompts the teacher to notice units of activity in a community and adapt them to the training of the pupil. To this end we see pupils compiling lists from the advertisements of local mark down sales to supplement percentage work in arithmetic; computing the cost to the town of the walks and macadamized streets near their homes; proof-reading the local newspapers and suggesting better expression instead of taking this material from the stereotyped grammar, applied English, is it not? We see them conducting anti-fly campaigns to supplement and vitalize the biology work and in a hundred other ways coming close to actual conditions of life. Any one of these things is a communal unit. That it has a definite bearing upon the welfare of society does not in the least detract from it as an educational factor. Any instructor who is interested in this phase of applied education can make chemistry conserve the community interests.

In order that this teaching may be effective there must be no turning pupils loose upon the town, no indiscriminate selection. That a method may be fruitful, there must be systematic investigation, but too often this investigation is pushed to, and even beyond, the fatigue point by insisting upon the examination of substances which are apart from the pupil's experience and in which he sees nothing except a school problem.

"Why can't we examine the things we would like to test instead of having to everlastingly work on some white powder or other?" remarked a high school boy yesterday. I asked what he would like to examine and he replied, "Waste from the gas works." Further questioning brought out the information that he had been reading in one of the popular magazines concerning the utilization of waste material and was enthusiastic over the chemical possibilities of the subject. His instructor had said that he did not want him "fussing around the laboratory with any gas mud." This perversion of pedagogy needs no comment.

As illustrative of two different methods of gaining chemical experience note the following: Sodium and potassium are most easily detected by the flame test, which consists briefly in holding a clean platinum wire wet with the solution in the blue flame of the Bunsen burner. A yellow coloration indicates sodium, a lilac tint, potassium. That the color image of the volatilized elements may be filed for future reference, it is customary for the instructor to provide relatively pure salts of these respective metals, thus working from the known to the unknown.

Up to this point the two methods are identical, the digression begins with the application of the acquired knowledge. Two courses are open to the teacher, he may *require* pupils to examine several liquids or solids which the laboratory provides thus keeping chemistry strictly within the school building or he may *permit*, note the difference in the pupil's attitude caused by the words "require" and "permit"—he may permit the pupil to examine substances of his own choice for the presence of such important elements. Here, taken from a pupil's notebook is an abridged list of substances found to contain sodium or potassium:

perspiration
ash from meats, cereals, vinegar, and milk
soaps and washing powders
soils, water residues, fertilizers.

As this investigation was entirely voluntary on the part of the pupil, sodium and potassium take a definite and lasting meaning not acquired by the bottle method of the laboratory.

Their reaction upon the community is understood. Of all instructors, the teacher of chemistry is among the most fortunate because of the abundance, yes, wealth of correlated communal interests, every one in some degree dependent upon chemical investigation. If not dependent upon, at least bettered by such research. Where can be found a more enthusiastic body of investigators than a class of chemistry pupils who do their work by the method of the *beckoning hand* rather than by the method of the *clenched fist?*

To turn the thought of the pupil towards some of the problems which occur in every town is doing a distinct public service. Chemistry originally came from the people, why not give it back to them again?

Here are some suggestive problems, the solution of which incites the pupil to continued effort along chemical lines. Some of these problems are to be studied and then reinvestigated from

time to time during the course to note any specific changes or possibly improvement in conditions. They may be roughly classified under two heads as recurrent or permanent problems; sporadic or temporary problems.

A sanitary analysis of water with the determinations of color, odor, taste, total solids, chlorin, ammonia, nitrites and nitrates, phosphates, absorbed oxygen, dissolved metals, and hardness.

If one knows what significance to place upon these factors, tabulated results of waters from different sources are not only of interest but of value. It has been our experience that every pupil is anxious to test his favorite spring and compare the results with other supplies.

Analysis of milk with determinations of fat by the Babcock method, total solids by Richmond's milk scale, proteins and milk sugar by the formulas of Olsen, Van Slyke, and Lythgoe. The last three determinations give excellent drill in applied mathematics. After the determination of these normal constituents of milk by means of which a more or less arbitrary grade is established, an examination of the sample for foreign matter, adulteration by means of dyes, preservatives, added water and by skimming is not only important but essential.

Surveys of the local supplies of ice cream, cheese, and condensed milk. Pupils usually take the greatest interest in determining the composition of ice creams as regard fat, fillers, gelatine, etc., they enjoy the search for preservatives in cheese and the grading on the butter fat basis and take pride in being able to say with assurance that "this sample of condensed milk contains 6.64 per cent of butter fat and is twice condensed, while that one contains only 3.31 per cent and is made from skimmed milk."

The detection of coal tar dye in candies almost always results in a lessened consumption of cheap confectionery in the town where the investigation is conducted. Many dealers sell, and many children eat this debased product, simply because their attention has never been called to the fact that mineral dyes are injurious to health.

For girls, simple chemical surveys of dentifrices and cosmetics afford opportunities of no mean value. Many of the common radicals, such as CO_3, Cl, PO_4, NO_3, S, BO_3, many important bases, as Hg, Pb, K, Na, S, Si, Ca, etc., are met with and identified by appropriate tests. This knowledge rightly secured, that is,

secured by the free will of the pupil, forms a valuable background of chemical information.

To the average pupil there are few more fascinating lines of investigation than well-planned distillation experiments. Each of these may be made to affect the community as well as the pupil if the instructor so desires. In order to master the technique of distillation, it may be well to allow the operators to purify several samples of water, which their previous tests have shown to be contaminated.

The addition of a little dye like Ponceau red sometimes serves to bring out the fact that volatile substances only can be separated by distillation. As soon as pupils acquire a fair degree of skill in this work they can be given several entertaining and valuable exercises in the extraction of essential oils from various herbs and spices.

The common wintergreen (Gaultheria procumbens) twigs of the sweet birch and ground cloves furnish suitable material for such experiments.

It is not a difficult matter for the pupils to determine the alcoholic content of patent medicines, tonics, invigorators, liquors, tinctures, root beer extracts, etc., with accuracy to the second decimal place, which is as far as we usually calculate in ordinary commercial analysis. While this work may not materially lessen the consumption of alcoholic beverages in any community, it has resulted many times in making the parents exercise a caution in the selection of medicines for family use.

The other day I gave a bottle to some students who were anxious for more chemical investigation. The liquid is the soak water from a local tan yard. Bombay hides had been washed and hundreds of gallons of the liquor accumulated. The proprietors of the tannery did not dare to drain it into the stream lest it kill the fish, nor throw it onto the land, lest cattle be poisoned by eating the grass. They exercised this caution because they had heard that Bombay hides are sometimes preserved with arsenic, and furthermore this liquor looked different from any they had been accustomed to see.

A sample was accordingly submitted to the laboratory. The question was: Does this liquid contain anything injurious to animal life?

After due investigation, the students found that the liquor was not only arsenical but also contained mercuric chloride. So the

question was answered and a problem solved. Here are examples of other local problems which have been solved by the pupils:

Coal from a local concern found to contain an excessive per cent of ash and a correspondingly small amount of available carbon. The firm had nearly decided to purchase a supply of this material but waited for the report from the laboratory and it was well they did.

A post preserver offered to a telephone company was found to consist of salt and baking soda.

You will note that in order to do this work it was necessary for the pupil to recognize two bases and two radicals.

A preparation for leaky automobile radiators was found to consist of linseed meal, colored with coal tar dye and scented with oil of mirbane.

Fake preparations purchased by unsuspecting housekeepers supposed to render kerosene and gasoline safe, consisted of common salt colored with coal tar dye.

"Lightning Silver Plating Fluid" for the instantaneous plating of brass, copper, and composition metals, contained no silver but was composed of red oxide of Hg dissolved in HNO_3.

Time will not permit us to give examples of scores of other investigations of like nature. We are convinced that the health of the pupil is of primal importance and have seen that chemistry may be made to conserve this important asset. The food supply holds a prominent place in eugenics. From this supply can be drawn innumerable chemical exercises, easily within the scope of the laboratory, and entirely within the concept of the pupil. It appeals to us as good pedagogy to let the pupil get the first-hand knowledge of the common chemical elements by doing actual work with them. They must not, however, get the idea that they are chemists and must be shown that the approach to chemical perfection is hard and difficult. By studying the interests of the class, and conditions of the town one may readily make chemistry teaching perform a service which is reasonable and offer a reason which is serviceable.

CALIFORNIA'S GREAT OIL OUTPUT.

California broke all records in 1910 in the production of oil by a single State. Her output was nearly 35 per cent of the greatest oil production ever attained by the United States. The California wells, according to the Uunited States *Geological Survey's* report on petroleum, contributed 73,010,560 barrels to the total, which was greater than the production of Russia, the second producing country in the world.

THE PROBLEM OF THE PUPIL WHO FAILS.

By Marion Sykes,
Bowen High School.

The problem of the pupil who fails is an ever-present one. It is the question of how to reduce the amount of waste in our business, a question of especial importance in the management of the school, for not only does it mean waste of public funds, but what is far more serious, waste in human lives. To the fact that the time of those who fail is used not only to no advantage but often to the pupil's positive disadvantage, is added the unfortunate result that the time of the many industrious pupils is sacrificed, while the attention of the teacher is given to the few indifferent ones. We deplore the attitude of many pupils, their lack of responsibility toward school work. We are unable to understand their willingness to come to class with lessons unprepared. Even the easy lesson assigned the first day is cheerfully neglected. If the trouble lay with pupils of one subject or group of subjects, with a few teachers, or a few schools, the inquiry into causes and remedies would be limited; but these unfortunate conditions are found in the case of pupils of all subjects, with all teachers, in all schools. The inquiry must be a broad one which will include conditions as they effect pupils widely.

The records of the school indicate a waste of time which ought not to be. Too many fail of promotion into the next grade. In one high school eighty-one per cent of the membership of the September classes were promoted last June. Ninety-one per cent of the fourth-year pupils were graduated; ninety-four per cent of the third-year pupils entered fourth year; eighty-eight per cent of the second year pupils entered third year; sixty-nine per cent of the first-year pupils were promoted to second year. Of the first-year boys, fifty-seven per cent were promoted, seventy-eight per cent of the girls. In reducing the number of failures it is evident that attention should be given especially to conditions in our first-year classes. Of course the worst cases never become second or third-year pupils, just as the worst cases in the elementary schools never get to the high school. Of those who are promoted into the next grade, too many are behind in one

or more subjects. Of those promoted from the first year to the second year in the high school mentioned, thirty-seven per cent were behind in one or more subjects; fifty-nine per cent of the boys, twenty-four per cent of the girls.

In spite of this we pass many who we feel are not deserving of the credit we give them. We lack the courage to fail all those whose work has really been unsatisfactory. Too many fail in our schools, but often too many who ought to fail are passed by the individual teacher. Just here is one way in which the school falls short of the moral training it owes the child. How can the giving of credit to a boy or girl who knows that he has done poorly and whose companions know that he has done poorly, strengthen the character of the pupil himself or of the other members of the class?

Some say that so many fail in the several subjects because one standard of seventy-five per cent in each subject is too high. So it would be if seventy-five per cent meant that the pupil had done three fourths of the work. No one but our critics think that. Seventy-five per cent means passable and might as well be sixty-five or even fifty per cent. A lower passing average would not mean that we would put more pupils through but that our marks would show more nearly what part of the work had been done. As it is, in most cases, fifty is "the highest mark which stands for zero." The requirements for promotion from first to second year are liberal. If a pupil has done passable work in all subjects he receives four credits or more at the end of the first year. He is promoted if he has received three credits, if he has passed in three fourths of his work. That surely is not exacting. Failure to pass does not necessarily mean that a pupil has received no benefit from his work. Often he has really improved and when he goes over the subject a second time, he finds himself and does well.

In looking for causes and remedies it is well to consider the conditions found in the elementary school before considering those in the high school. This is a difficult portion of the subject to approach because of the certainty of being misunderstood. There is no desire to criticise the elementary teacher. The fault is in the system. When we consider the conditions under which the elementary school is working, the wonder is not that the pupils do so poorly when they

come to us, but that they do so well. The fact that the worst conditions are in the first year, that the children at the beginning of their high school life make so little effort to do the work assigned them, indicates that no real improvement can be made without beginning with the elementary school.

One trouble with the children is the unfortunate understanding of certain psychology. It has been urged upon the teacher to arouse the child's interest. Does arousing interest consist in amusing the child? Is interest to be gained only by firing a pistol or engaging in a procession? If we receive only involuntary attention which does not lead into voluntary attention the child is not being prepared for his place in life. Dr. Münsterberg asks, "May it not be that the most important aim of education is just the power of overcoming the temptations of mere personal interest, the power to serve purposes which demand effort of will and discipline of attention?" The result seems to us too often "a flabby inefficiency, a loose vagueness and inaccuracy." Our education must be such that those who go out from us will not continue "to follow without check their untrained impulses." Another doctrine which has been distorted is that the responsibility is on the part of the teacher. If she but do her duty the pupil cannot help but learn. This has been pushed to such an extreme that the pupil has unconsciously absorbed it. Often his attitude seems to be "interest me and I'll do well; but I myself have nothing to do."

There are other causes, however, which are more effective in bringing about the results we deplore. Often the pupils are handicapped physically. Bad tonsils, adenoid growths, poor eyesight, defective hearing, flat foot, and lack of sufficient food of the right sort are often to blame for backwardness. Fortunately society is waking up to the tremendous physical handicap placed on some children. The child-study department is ready to help teachers toward a solution of the difficulties of such pupils, and in some cases special instruction is provided. The school system is working to reduce the ill effects of such conditions.

Some think that the system of passing pupils from grade to grade below the high school on a general average of seventy-five per cent, means necessarily a failure on the part of certain pupils in certain subjects. In some elementary

schools the marks in writing, drawing, music, composition count as much toward promotion into the next grade as the marks in reading, arithmetic, history, or English. Some children may pass on very good averages who never stood above sixty in arithmetic for example. Of course such a child could not make the necessary seventy-five per cent in algebra required in the high school. This method of promotion would result as claimed in the case of certain children, but on the whole it seems as good a method as any for promotion in the grades below the high school.

There are four other causes which are much more unfortunate in their results than any mentioned thus far. They are the large number of pupils under the charge of one teacher in the lower grades, the crowded condition of the curriculum, the character of the text-books used, and the bad habits of the pupils themselves. In the elementary school the average membership of forty-five in a room is not so large as formerly when teachers of the third grade, for example, had in some cases fifty-seven under their charge. The rule works out an average of from forty-five to forty-eight in a room with a tendency to fewer in the higher grades. This is in advance of what it used to be but there are still too many. With such large numbers how else can the teacher do but treat the pupils in the mass, accept short, scrappy answers, and push on as many as possible to make room for the incoming crowd? She aims to demand careful answers, to give each child some individual attention; but the teacher can do only her best with the large number of pupils in her care. We object to our large classes in the high school, and we deplore the lack of responsibility shown by the child. We will not succeed in the results we wish until the large numbers in the rooms in the lower grades are reduced. This is a difficult matter to adjust, for a large city like Chicago grows so rapidly that the schools do not easily keep up with growing and changing population. Then there is a mysterious something called "business interests," which makes it better economy to save dollars and cents, rather than boys and girls.

The crowded curriculum is another difficulty with which the elementary school must contend. The mastering of all the work laid down for the elementary school is an impossibility. Attempts to cover the work would seem to result in

confusion with little or nothing done well. Besides the large amount of work in each subject to be done, new subjects or new phases of old subjects are introduced in a way which means a crowding out of something to give time. This class of difficulties may be illustrated by the experience of a second-grade teacher. She had a room of forty-five pupils whose program allowed ten minutes a day for physical culture. She was instructed to make dancing a part of this work. Not being able to teach forty-five children to dance by giving them ten minutes a day, and being obliged to put in the dancing, she had to take time from other subjects. Lessons in reading are required to be dramatized. The time allotted to reading on the program must be extended to allow of any results worth the name. It is not my intention to urge against folk dancing or dramatizing in themselves, but to urge that when those in authority wish these things to be included in school work the program be so adjusted that they aid the pupil in his study of the fundamentals, not crowd out the fundamentals. Too often construction work unrelated to other subjects is introduced in the same way, and there fails to be laid the foundation needed by all American citizens no matter what their life work is to be. A boy who was in his second year in the high school was overheard to say to a first-year girl, "What did you fail in? Algebra? Bet I know what school you came from. Same as I did. Scissors and cardboard, cardboard and scissors, but not much arithmetic."

Accounts of the work of teachers in getting up programs for school entertainments come to us and we hear of how a teacher leaves her class work and drills groups of pupils who have left their work. We wonder if the pupils have gained more than they have lost. We know that our work could not stand that sort of thing.

The character of the text-books used in the elementary schools is another serious drawback. Many of the books are beyond the comprehension of the pupils. It is impossible to expect the child to take the book and get anything from it for himself. He cannot learn to read from such a book, and his best efforts result too often in discouragement and confusion. No wonder that he gets into the way of coming to class not with a poorly-prepared lesson, but with a lesson which he has made no attempt to prepare. In some cases

there seems to be no book written on the subject which is within the comprehension of the child. Yet it surely is a part of the work of the school to teach the pupils to take a book and get out of it valuable information.

The worst condition to contend against is bad habits on the part of the pupils themselves. Take for example smoking on the part of small boys. They tell us that of twenty-four hundred smokers whose record was examined, less than one hundred and fifty were up to their grade in school. That of the boys from two to four years behind in their grades most of them smoke. With smoking go physical defects, and bad habits which make it difficult for a boy to develop will power.

These are some of the drawbacks against which the elementary school is working. If our failures in the high school are to be reduced in numbers, improvement must begin in the elementary school with fewer pupils to a teacher, a simplified curriculum, easy texts within the comprehension of the pupils, and a coöperation of home, school, and social interests which will work against poor health and bad habits of the pupils.

In the high school conditions of the same general character as those in the elementary school are met. Our point of view is an important matter. Too often this has been that of the specialist, not the point of view of the child. If we find the pupil unable to do what is our idea of high school work, then we should give him what he needs, not what we think the ideal pupil ought to have. Our methods, our subject-matter must be adjusted to the needs of the pupil who comes to us, not to the pupil who, we think, ought to come. If our pupils need what we consider seventh-grade work, then we should give them seventh-grade work. We are often too much afraid of making our work easy. The hopeful thing about this situation is that we are improving and our point of view is becoming more and more that of the child.

We are afraid of being judged mere hearers of lessons rather than teachers, and in order to avoid such an imprecation we sometimes assign very little definite work. We must make assignments for daily work definite, and the pupil must be held responsible for the preparation of all work assigned. Passing pupils who have habitually done slipshod work not only results in sending into higher classes poorly

prepared pupils, but it has a bad moral influence on the children themselves.

The numbers in our classes seem to many of us to make it impossible that a large per cent can pass. Our largest classes are in the first year where the failures are the most. The people who are failing need individual attention. We all know that with forty-five pupils reciting in fifty minutes, few can get individual attention. Those who go to class unprepared are the same ones who go to the study room with nothing to do, or with a story book to read. That is one of our perplexing questions, "Why is a pupil willing to loaf out a study hour and go to a recitation the next period with the lesson unprepared?"

Our texts, as well as the texts in the elementary schools, have not always been adapted to our pupils. They are written by specialists who often have not the pupil's point of view. This condition is steadily improving. We are getting rid of some books which are too difficult or which are inadequate.

The matter of the habits of the pupils is a serious one, especially the habits of the boys. In one high school it was found that of the first-year boys who had been in school a year last June but who were behind in one or more subjects, thirty-six per cent were known to smoke. Seventeen per cent of those behind in one subject smoke, eighteen per cent of those behind in two subjects, sixty-eight per cent of those behind in three subjects, and sixty-one per cent of those behind in four subjects are known to be smokers. Of those who passed in all subjects none smoked. Smoking is a habit which accompanies other habits, all of which work against the mental growth of the boy. I made a list of those I call the "boldest smokers," those who will stand smoking, leaning against the schoolhouse almost at the very doors unless they know a teacher is coming. They are all pupils who fail in subject after subject, pupils who have taken the time and attention of teachers and principal for repeated disorder.

What about the girls who fail? I don't know. In the case of some their health is poor, most seem to be plain lazy, a few unable to do the work of the class. If we could bring the proportion of boys who pass up to the proportion of girls who pass we would be a long way ahead. I asked some of the boys about it. They said, "When school is out a girl has to

go home. At least her people know where she is. When school is out a boy goes to the gym or the park; maybe he bums around a street corner and goes to the show or pool room, and gets home in time for supper." It used to be said that introducing manual training and shop work would hold the boys. We find that with only few exceptions, those doing well in academic subjects do well in shop, and those failing in academic work do poorly in shop.

The subject is a large one. What can teachers do to help? It will not help to mark all pupils through. We wonder if our influence would be of any use in bettering the conditions in the grades. We can adjust our work continually to fit the pupil as he comes to us, not as we think he ought come. We can continually point out the handicap a pupil has when he is a member of a crowded class. When a change of textbooks is probable, we can use our influence toward a simple book which the pupil can actually read and understand, and which is definite and adequate. How can we work effectively against bad habits which undermine the mental power, the will, the character of our boys, habits which were formed outside of school, before they came to us?

EPIDEMICS OF SO-CALLED INFLUENZA.

Since the pandemic of influenza in 1889-90, when within one year the whole civilized world was afflicted with the contagion, there have been lesser outbreaks at irregular intervals in most centers of population. These epidemics of sore throat and bronchitis have usually been called influenza or "la grippe," because of the characteristic contagiousness of the infection, the persistence of the symptoms, and the tendency to prostration and mental depression. But this diagnosis has not been satisfactorily confirmed by bacteriologists. In the great pandemic, Pfeiffer and others found in the nasal and bronchial secretions "pure cultures of the influenza bacillus in all uncomplicated cases." Subsequent reports seem to indicate that the influenza bacillus is a common invader of the air-passages in a large group of other diseases, notably whooping-cough, phthisis and measles. There is no evidence that this bacillus is more prevalent in the local epidemics of influenza than in the ordinary catarrhal infections. A recent epidemic of "septic sore throat" in Boston was studied by Richardson and others. They traced the contagion to infected milk. A study of an influenza epidemic among children in Berlin and of the recent epidemic of sore throat in Chicago have demonstrated as the exciting agent a germ of peculiar characteristics different from the influenza germ. *The Journal of the American Medical Association* points out that these three epidemics occurring during the last year in widely separated communities, have all been caused by the same germ. It is to be hoped that in the future such epidemics in various cities will be more systematically and carefully investigated.

MATHEMATICS IN THE ELEMENTARY SCHOOLS.[1]

BY ADELBERT H. MORRISON,
Mechanic Arts High School, Boston.

You may wonder that a high school teacher should have been chosen to speak on elementary school work, and the fact that such a teacher was found to accept the invitation is perhaps only another manifestation of the inalienable right of the higher school to assume a wise attitude toward the work of the lower. However this may be the subject of the elementary school curriculum is more important now than it has ever been before; and this relative importance is likely to increase rather than diminish so long as the present economic and social conditions exist. It is undoubtedly true that the influx of foreign peoples from the lower classes of the nations from which they come has materially affected the average of mental and moral development of the children in our schools. The crowding of people together in cities and large towns, the tendency toward the apartment house or flat, both have tended to change materially the average conditions of life and have brought their results in the enriched course which has received so much criticism. It has been said that the schools are now teaching what should have been taught in the homes, and this is no doubt true; but the fact is that certain things that were taught in the home a generation ago, or less, are not so taught now and it is a question whether they shall go altogether untaught or receive some share of attention in school. Personally I believe that the elementary school curriculum of the present day is an attempt to make formal education what it should be, a supplement to other educational forces that are less completely under our control, with a view of bringing about a more complete development of the mental, moral, and physical characteristics of the pupils.

Another condition that is adding to the importance of the work of the lower grades is the fact that the number of pupils who leave school as soon as the law will allow is continually on the increase. I have no data on the subject but I believe it is true that the percentage of pupils who leave school at an early age is greater now than it was five years ago. I do not see how this can fail to be true. None of us here are rich in this world's goods, perhaps, but we all know that the purchas-

[1]Read before the Association of Mathematical Teachers in New England, Feb. 3, 1912.

ing power of a dollar is decreasing to an extent that is alarming to all and distressing to the poorer classes of society. Consequently, it is certain that more and more people are living close to their income, and more pupils are leaving school from force of necessity than ever before. The elementary school, therefore, is their only hope, until part time and continuation schools have reached a higher stage of development than they have at the present time.

However, this does not help us to solve our problems, but only serves to emphasize the need of making every moment of time in the lower grades count for something worth while in preparing the great body of pupils to take their places in the world and lead lives that are something more than mere existence. I do not believe that this necessarily means that the lower grade work must be made purely utilitarian. This would be an unfortunate starting point from which to plan out the subject-matter of any school course, but I do think that some of the work we are now attempting to do is too difficult for the pupils at the time it is attempted, and that the emphasis should be placed at different points than is the practice at the present time so far as I am acquainted with that practice.

I have referred to the enriched course in the elementary schools and to the fact that this enrichment has received bitter criticism from many quarters, but I seriously doubt if any superintendent would dare to brave the storm that would be produced by attempting to return to the old curriculum, even if he thought it sound educational policy. These new subjects are here to stay and we may as well face this fact squarely. But there is another fact brought home to us on every possible occasion by all sorts of people, and that is that the results of our elementary school work are not satisfactory. The president of a bank said recently, at a meeting of school men, that he had yet to find the grammar school graduate who could read intelligently, write legibly, spell correctly, or add a column of figures with any degree of accuracy, and although this statement of the case may be somewhat exaggerated it is typical of the opinion held by a large number of business men. High school teachers, I am obliged to confess, are sometimes equally outspoken in their criticism and offer as an excuse for their own failures the fact that pupils are not properly prepared, as though preparation for the high school were the object of the elementary school course. Sooner or later the community is

going to rise in arms against the wholesale failure of pupils in the early part of the high school course and insist that teachers shall base their requirements on the ability of pupils to meet them and not upon their own standards of what these requirements ought to be.

But to return to the point about which I was speaking, it is a conservative estimate that twenty per cent of the time spent in the elementary schools is spent on music, drawing, manual training, sewing, cooking, nature study, physical exercises, and similar frills, while the total number of hours spent in school is no greater than before these subjects were introduced. It might be mentioned also in this connection that the teaching of the English language to foreign-born children merely as a vehicle of communication is consuming considerable time at the expense of other subjects, and that the average of intelligence among pupils in our schools is undoubtedly lower than it was a few years ago.

We have, then, the problem of trying to do more teaching in less time, and there is a limit to the possibility of so doing without seriously reducing the efficiency of the teaching. It is the old question of two bodies occupying the same place at the same time.

Now under the conditions which I have just described one of two things must happen. Either we must reduce the content and improve the teaching of the subjects which we are attempting to teach, or we must expect the results to be less satisfactory than formerly, and it is particularly in regard to arithmetic that I am supposed to speak to-day, although similar suggestions might be made in regard to technical grammar, political geography and history.

I have said that either the content of the course in arithmetic must be reduced or the results of our teaching must suffer, and it requires little argument to convince the average business man that the latter, at least, is an accomplished fact. Improvements and modifications in methods of teaching have not made up for lack of the time which is absolutely essential for drill, and it is probably true that the average boy now does not compare favorably with the average boy of a generation ago in ability to use arithmetic or in accuracy in the mechanical processes involved.

We are brought, then, to the necessity of reducing the con-

tent of the subject as one means of saving time and there is one other suggestion that I wish to make later that would, I think, relieve the situation to a considerable extent. But do not anticipate that I am going to suggest that any person could live a complete and satisfying existence without the ability to work out the length of time it would take a sum of $87.45 to amount to $110.15 if placed at compound interest at 5½ per cent or to find the number of square inches in a ten acre lot. Such ability is of little value to the ordinary individual, it is true, but if there is a class of pupils to whom these things are of value, let them be taken up in the high school, when the time so spent will not be taken from other things that the great bulk of the children can ill afford to lose. I have for a long time maintained that it is worse than useless to attempt the kind of algebra that is usually taught in the first year of the high school, and that at least half of the years should be spent on arithmetic, special attention being given to the use of the equation in solving types of problems that are already familiar.

But to return to the subject and to come down to particulars, the modification of the elementary school course in mathematics that I have suggested is that the elementary schools should omit a considerable part of what is now being taught in arithmetic and confine themselves largely to those things that are likely to be of use to the greater number of children who enter the unskilled vocations, and let the high schools take care of the other pupils. If a further study of arithmetic seems desirable for high schools, either for its vocational value or as a preparation for higher mathematics, why not let those schools teach what they will and as they will? This would at least have the advantage of enabling the high schools to specialize to some extent on arithmetic, the pupils in a commercial course putting special emphasis on interest, stocks and bonds, commission, etc., those in the mechanical course on mensuration of surfaces and solids and the use of formulae, while all would bring to the study the interest accompanying the consideration of new material.

But before going into further detail in regard to the content of the course, there is another way in which our time is not used to best advantage, and it seems to me that the greatest possibility of improvement is through a reallotment of time to written and oral work. A little consideration will convince you, I think, of the immensely greater value of the ability to do

simple problems mentally than the more difficult ones with pencil and paper. I have made careful inquiry among all sorts of people in regard to the use of arithmetic in their everyday lives, and find that surprisingly few have occasion from one week's end to another to resort to written arithmetic while all are doing mental problems many times a day. The housewife, for example, is buying her provisions, cloth, etc., and making use of yards and pounds. The carpenter is concerned with feet and inches, the machinist with inches and parts of inches, but the problems involved are for the most part those that can and must be done mentally and quickly. Hence I believe that a great deal of time that we are now spending on written work is wasted and might better be employed in oral drill, on problems of the same sort, perhaps, but involving simpler relations and smaller numbers. Think, for example, of a class spending thirty minutes or more every day on eight or ten examples like the following:

1. Change $\frac{33}{53}$ to 212ths.
2. Reduce to lowest terms $\frac{856}{936}$.
3. Reduce to an integer or mixed number $\frac{64721}{375}$.
4. Add 32[illegible], 18[illegible] and 45[illegible].
5. Multiply 18[illegible] by 37.
6. Divide [illegible] of [illegible] of [illegible] of [illegible] of 6[illegible] by [illegible] of $\frac{9}{16}$ of [illegible] of $7\frac{1}{2}$.
7. Change 641,558 inches to miles.
8. Change [illegible] ft. to a fraction of a mile.

I wonder how many oral examples involving the same processes but smaller quantities could be done in the same length of time? If I were to guess I should say at least three times as many. It is not a question here of "what knowledge is worth while," for it is all more or less valuable, but what knowledge is *most* worth while considering that we cannot do all that we might desire.

This, then, is my first specific recommendation—to reduce greatly the amount of time given to written work and to increase the time spent in oral drill correspondingly. Moreover, I would reduce the size of the numbers used in written work and confine them to those of common occurrence. I would use smaller numbers and give more problems rather than obscure the process with numbers that are unnecessarily large. For example, in dealing with fractions I would use as a rule halves, thirds, quarters, eighths, tenths, sixteenths, and thirty-

seconds, avoiding sevenths, elevenths, thirteenths, etc., and restrict all denominators to two figures. It goes without saying that fractions whose denominators end in zero should be treated as decimals whenever possible on account of the saving of time and labor, and all use of fractions should be discouraged for the same reason. The subject of complex fractions should be omitted altogether from the elementary course. In both multiplication and division of fractions it should be considered a serious offense to omit any possible cancellation.

Before leaving the subject of fractions I wish to call your attention to the blessing that would be ours if we did not have to deal with fractions at all, except in mental work, and how nearly this would be the case if our system of denominate numbers were anything but the abomination that it is. I have made it a business for a long time to see that every pupil who comes under my charge thoroughly realizes this fact; and if every public school teacher would do the same it would not be as difficult in the next generation as it seems to be in this to bring about a reform that has already been delayed too long. This bit of instruction I am obliged to give in connection with work in the metric system in the early part of the course in science, and it takes the form of several examples like the following:

1. (a) How far would six tables extend if placed end to end, each table being 3 feet 10½ inches long?
   (*b*) How far would the same tables extend, each one being three meters 10½ centimeters long?
2. (*a*) Find the weight of 10 cubic inches of water.
   (*b*) Find the weight of 10 cubic centimeters of water.

These examples are done in columns on the same sheet of paper, part (*b*) of each example being opposite part (*a*), and it does not take many of them to convince pupils that a decimal system is a great saving of time. I might add, also, that the adoption of such a system in this country would mean a saving in the science course in the high school, where considerable time is always necessary in teaching the equivalents and in making changes from one system to the other. The mathematics of thermometry, for instance, would be entirely unnecessary under the metric system and the term specific gravity would go out of use.

For a long time it was thought that there could be nothing new in regard to teaching the fundamental operations, but the method of additive subtraction which has come into recent use

has practically reduced the number of such operations from four to three. This method of subtraction is probably so familiar to you that it needs no explanation, and consists simply in determining what number added to the subtrahend will give the minuend. For example, the pupil is taught to ask himself what number added to five will give eight, not how much is five from eight.

In teaching decimals I have only to recommend that method of division which consists in moving the decimal point as many places in both dividend and divisor as will make the latter a whole number, writing the quotient above the dividend. This brings the decimal point in the quotient in a vertical line with that of the dividend, and although it is still a mechanical device it has the advantage over the older method of greater simplicity and therefore it is an economizer of teaching time.

A similar method might be employed in the multiplication of decimals but I have never heard it suggested, and it lacks some of the advantages of the method just suggested in connection with division. In multiplying 34.7 by 1.87, for instance, we might change the decimal point in the multiplier in such a way as to make the latter a whole number, at the same time changing the point in the multiplicand just as many places in the opposite direction. The decimal point in the product would then come in a vertical line with that in the multiplicand.

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 34.7          .347
 1.87          187.
 ----          ----
              2389
             2776
             347
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             64.849
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In teaching denominate numbers there has already been a considerable reduction in the content of the subject, but I think there is opportunity for still further pruning. Due perhaps to the unconscious realization of the difficulties of our system, or lack of system, there has been going on in the past few years a process of evolution which is tending to eliminate some of our units of measure altogether, and to change others so that they will be a little less difficult to handle. As illustrations of this let me call your attention to the growing tendency to allow the unit of length called the rod to fall into disuse. Comparatively few people now think in rods, and I for one am obliged to go through the troublesome mental calculation of changing

to feet whenever rods are used. The same is true to a less extent with the yard, and I confess that the distance 100 yards means little to me until I translate it into feet. I am disposed to omit the rod entirely from the table of linear measure and place it in a footnote along with the fathom, furlong, league and other units once in common use. Another unit which is going through the same process is the gill. The dozen and the gross are now not nearly as common as formerly, dozens giving place to tens and gross to hundreds, and if a name were invented for a group of ten this process would no doubt be greatly accelerated. Many commercial articles are now sold in tens instead of dozens, and I am obliged to acknowledge that sometimes there is no appreciable difference in the price to the consumer. In the stationer's table the same movement is going on, the quire of twenty-four sheets giving place to one of twenty-five, and the ream of 480 sheets to one of 500. Articles that were formerly sold in units of dry measure are now sold by weight and the apothecary's pound is being merged into that of the grocer.

In all these steps I am in favor of aiding the process so far as possible and would suggest that little time be spent on those units that I have mentioned, as we are now doing with some others that have practically disappeared.

Mensuration might well be confined to rectangles and triangles. The trapezoid, which only occurs in board measure, can be treated as a rectangle, taking the average width of the board as the width of the rectangle. Carpeting and papering could be omitted from the elementary course and left for the high school, as well as such subjects as longitude and time, present worth and true discount, commission, duties and customs, stocks and bonds, and exchange. These subjects all offer difficulties that are too serious for the immature pupils of the lower grade and belong properly in a higher course.

In square root where only comparatively small numbers should be used the method based on the square of the binomial should not be attempted. The method of resolving into prime factors is easily understood and is applicable to many cases, but for numbers that are not easily factorable the method of repeated trial may be used.[1] This involves the teaching of no new process and is easy to explain, although not economical of figures in some cases.

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[1]This method is described by Mr. George W. Evans in his recent monograph, *The Teaching of High School Mathematics* (35 cents), published by Houghton, Mifflin & Co.

I have tried to suggest thus far a few ways in which time might be saved from the written work in arithmetic in order that it might be devoted to the everlasting drill that is necessary if we are to secure any degree of accuracy. For there is no royal road to accuracy and speed, and the only way to secure them is to establish a condition of mind that produces an instant and automatic reaction in the presence of certain conditions without the intervention of any act of judgment. This does not mean that the pupils are to be taught not to think, but that they should be relieved at the place where thinking is of no use in order that they may use their powers to better advantage in situations that require them. And this reminds me that there is one time in the solution of every problem when most children consider that their thinking is done, and that is when they have arrived at a result. It matters little what the result may be so long as it may be labeled ANS. and placed in a selected spot on the paper or board.

Now, next in importance to securing accuracy is the ability to detect inaccuracy, and contrary to a common conception among children this ability should be developed in the pupil and not in the teacher. Consequently I believe we might profitably spend more time in teaching the pupil how to test his results, by accurate or by rough checking, the latter always and the former whenever possible. We are all familiar with the pupil who will unblushingly offer the information that a company of men must be formed with 12½ men in the platoon, or that it will cost $64.79 for stock to build a pine box to hold his pencil, eraser, and penholder. It has been said that the most valuable man in a shop is the one who can guess within ten per cent, and this is undoubtedly true, but to be of most value the guess should precede the formal solution, not occasionally but always. That is, the pupil should spend considerable time in thinking over the condition of a problem and make a rough estimate of what the result of his calculations should be before he is allowed to touch pencil and paper. Then having reached a result he should be taught to ask himself, "Is it possible?" and "Is it reasonable?" This is a method or procedure that I have never seen regularly and systematically carried out, but I believe it would be well worth the time required.

In this connection let me call your attention also to that time saving device called the slide rule, not because I believe in teach-

ing its use to elementary school children, but because it would be upon every teacher's desk if its advantages were once realized. It can be used in many sorts of calculations involving only multiplication and division, the result being read directly from the scale, and contrary to the common belief its manipulation is easily learned.

Having eliminated certain parts of the subject in the lower grades there are others that could be emphasized to the advantage of those who leave school early, especially in classes of boys. There are few indeed who do not stand in need of a knowledge of bills and accounts, and many are at one time or another concerned with notes, coöperative and savings banks, life insurance, taxes, and mortgages. Among foreigners, especially in the smaller cities and towns, there is a well-defined tendency to buy small pieces of land at a little distance from the center of population, the capital being secured by means of notes or mortgages, and through their ignorance these people are often defrauded of what to them are large sums by unscrupulous speculators. Therefore it seems that the simpler transactions of banks and real estate dealers deserve some consideration in the latter part of the elementary school course. Interest, both simple and compound, should be emphasized. The former should be taught by the two months method, and the latter by means of tables after some simple preliminary work to bring out the principle involved.

As an introduction to work in percentage some instruction should be given in handling the simple equations, as many of the problems involving base, rate, percentage, and the amount are much simplified by the use of symbols, these symbols consisting of the initial letters of the words for which they stand. For instance, it is entirely within the comprehension of a seventh or eighth grade pupil that $P=B\times R$ is only a shorter way of saying that percentage is equal to the base multiplied by the rate, and having once learned this and the fact that both members of an equation may be multiplied or divided by the same quantity, he does not need to puzzle his brains to think whether the rate is equal to the percentage multiplied by the base, or the percentage divided by the base. He can pass easily from the statement $P=B\times R$ to the others $P/B=R$, and $P/R=B$. Similarly since $P=B\times R$ and $A=B+P$ then he can be made to see that $A=B+B\times R$ and $A=B(1+R)$. If this method of approach is too difficult for the class in hand then the latter

part of the above should be postponed until a later date, but I do not believe that this will be the case.

In regard to board measure and the areas of surfaces when the latter are expressed in feet and inches, I wish to call your attention to a short method of calculation which is still used as a rule of thumb by some carpenters of the older generation but which has entirely disappeared from the arithmetics of the present day. Suppose for instance that we wish to find the area of a surface that is eight feet four inches long and six feet ten inches wide. The usual method is to reduce both dimensions to inches, multiplying the resulting equivalents and divide by 144, thus:

7 ft. 3 in.=87 sq. in.
6 ft. 10 in.=82 sq. in.
87 in.×82 in.=7,134 sq. in.
7,134 sq. in.÷144 in.=49 sq. ft. 78 sq. in.

Now one of the carpenters mentioned would proceed as follows:

7 ft.		3 in.
6 ft.		10 in.
	70 parts	30 sq. in.
42 sq. ft.	18 "	
42 sq. ft.	88 parts	30 sq. in.
7 sq. ft.		48 sq. in.
49 sq. ft.		78 sq. in.

If he reasoned at all about the matter he would say, "When I multiply inches by inches I get square inches. When I multiply feet by inches or inches by feet I get a unit which is one-twelfth of a square foot or 12 square inches. When I multiply feet by feet I get square feet. Now the first and last units are the only ones in common use so I will change the third into square feet and square inches." You will notice that this involves only multiplication and division which can be done mentally and a little addition, an improvement I think over the first method; the chances for mistakes being in the ratio of one to five at the very outside. This process need not of course be confined to cases involving feet and inches, but can be adapted to the mensuration of any surface whose dimensions are expressed in the same two units, if care be taken to determine the relation of these units to the third which it becomes necessary to use. If for instance we wish to find the area of a surface seven yards two feet long by four yards one and one

half feet wide, it can be done in exactly the same way. Thus:

yd.		*ft.*
7		2
4		1½
	10½	3
28	8	
28	18½	3
6		1½
34		4½

There are a few short cuts in the longer operations of multiplication and division that deserve some time in the latter part of the course but they are very few, and among them may be mentioned these, which are valuable particularly in rough checking:

1. $$\begin{array}{r} 784 \\ \underline{213}. \\ 2352 \\ \underline{16464}. \\ 166992 \end{array}$$
2. $634 \times 98 = 63400 - 1268 = 62132$.
3. $217 \times 25 = 21700 \div 4 = 5425$.
4. $14.8 \div 12\frac{1}{2} = .1480 \times 8 = 1.184$.
5. $347 \times 11 = 3817$.
6. $(27)^2 = (25+2)^2 = 625 + 100 + 4 = 729$.

In conclusion I wish to suggest the addition of one topic to the subject in the elementary grades—one for which there was little need ten years ago, but one which now demands some notice. I refer to the graphical representation of the relation of two quantities sometimes in the form of two areas, and sometimes that of a curve. The comparative sizes of armies are often shown by men dressed in the national costumes, or the per capita wealth of countries by bags of gold, and the weather man shows by isobars and isotherms the variations in pressure and temperature throughout the country. Furthermore, the Harvard-Yale football game is reported in diagram in the Sunday paper, and what could be more important than we should all be able to follow every play? But seriously I have had pupils show more interest in finding the cause in the sudden change in the slope of a graph representing the growth of population in the United States since 1789 than they ever did in a formal history lesson, and incidentally I think they learned more history. This is a kind of work that appeals to younger people and might I believe be begun in the elementary schools.

There is one feature of the matter, however, which I confess gives me some uneasiness, and that is the persistency with which pupils speak of the process as "grafting." I try to get around this by giving them a piece of coördinate paper and telling them that anything that is plotted on the square cannot be grafting.

To conclude this rather haphazard collection of suggestions let me say that my work for the past ten years has been in a high school for boys and consequently my intimate knowledge of grammar school methods may be considerably out of date. It may be that all the suggestions I have made that are worthy of attention have long since been adopted and that many others of which I never dreamed have been put into practice.

CONCERNING LOCI.

By Rose Standish Hardwick,
The Mary A. Burnham School, Northampton, Mass.

That the subject of loci has gained greatly both in prominence and in real importance in the last twenty years is evident; that this gain is likely to continue for some time to come would probably be granted by most people who are in touch with the mathematical work of secondary schools and colleges.

Perhaps it is safe to assume that in view of these facts not a few teachers in secondary schools share my own dissatisfaction with the usual treatment of the subject. It seems to stand by itself, not an integral part of elementary geometry but a side issue; an edge tool that wounds the user as often as it helps him. We feel that it should be a most fruitful conception, something that relates more closely and securely many other conceptions and at the same time leads on to the discovery of still other relations both interesting and useful. Instead we find it too often only one more fagot laid on burdened shoulders and always in danger of toppling off!

Of course, if the student goes on, these difficulties tend to disappear, and sooner or later he comes to a full, and a grateful, appreciation of this method. But are the difficulties unavoidable? Is there no way to reach firm ground except through the Slough of Despond? And what of those who do not go on?

My own solution of the problem has been worked out gradually in the course of the last ten years of teaching, and has now been sufficiently tested to justify my offering it to others whom it may concern.

For the clues in this case, as in many another, I am indebted to William F. Bradbury, under whom, as head master of the Cambridge Latin School, it was my good fortune to teach. He proceeds on the supposition that the notion of "direction" is elementary, and by utilizing this notion he is able to give for straight line, parallel line, and angle, a set of definitions from which the subject of loci develops almost automatically.

"A straight line is a line that has the same direction throughout."

"Parallel lines are lines that have the same direction."

"An angle is the difference of direction between two lines."

Every child by the time he reaches high school understands what is meant by "direction" and by the "same direction." It is often necessary to draw attention to the fact that not all "different" directions are "opposite," but a few words make that clear. The first two of the above definitions commend themselves at once to the pupil. The third calls for some discussion, but is not difficult to make clear even to beginners with the aid of the rotating line. Once fairly well grasped these three statements stand in no need of correction or explanation, but become continually clearer and more significant with use; at the same time leading the mind forward, so to speak, and preparing it to welcome and appreciate a multitude of new relations.

The next point to be made clear is the fact that a line is determined when one point and its direction are known. It is worth while to go into this in detail, showing how an indefinite number of lines can be drawn in any given direction, and an indefinite number through any given point, but only one which both takes the given direction and passes through the given point. If at the same time the determining of a line by means of two points is discussed, it is well to draw attention to the fact that in either case two, and only two, conditions are necessary, or, in other words, that two conditions are necessary and sufficient for the determining of a straight line.

The student is now ready for the notion of a locus. I have found the following definition satisfactory at this stage:

"When a point moves according to some fixed law (or given condition) the line, or system of lines, which it describes is called its locus."

I tell the class that they will not see at once the need of the phrase "or system of lines," but that they will see it before we go

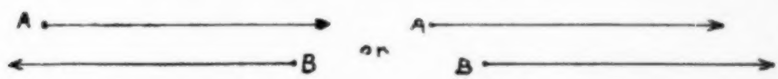
very far. As I work in this topic along with the usual introductory definitions, the class is already familiar with the idea that a point in motion generates a line, and the only new conception is that of motion according to law. This is readily illustrated by what I am in the habit of giving as the first locus.

No. 1. *The locus* of a point in a given direction from a given point is a straight line drawn from the given point in the given direction.

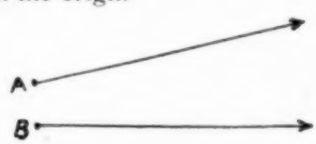
This is followed at once by an application in the problem: To find a point, knowing its direction from two given points. The solution is found by intersection of loci, and in the discussion it is seen that the problem may have

(1) One solution, the only case usually considered,

(2) No solution, when the loci are parallel,



or when an intersection can be found only by prolonging them backward through the origin



(3) An indefinite number of solutions, when the two loci coincide through a part of their extent

Special cases of this problem are found in the proof by superposition of the equality, or congruence, of two triangles having a side and the two adjacent angles of one equal respectively to a side and the two adjacent angles of the other; and in the corresponding problem of constructing a triangle when a side and the two adjacent angles are known, etc. Whenever these propositions are studied, their connection with Locus No. 1 should be brought out, and emphasis laid on the fact that the directions of the lines are given by means of angles in accordance with the definition of angle which has been adopted.

If the definition of circle has not been given already, it will be needed now, and the fact should be carefully discussed that a circle is determined only when both center and radius are known. We are then ready for—

No. 2. The locus of a point at a given distance from a given point is the circle described with the given point as center and the given distance as radius.

This also finds immediate application in the problem of determining a point when its distances from two known points are given; and we have there the six positions of the circles, two giving intersecting loci and therefore two solutions, two giving tangent loci and therefore one solution, and two in which the loci have no point in common and therefore we have no solution. It is hardly necessary to mention the special cases of this problem in the usual series of propositions.

The next step is to apply No. 1 and No. 2 together in the problems:

To find a point whose distance and direction from a fixed point are known, and

To find a point knowing its distance from one fixed point and its direction from another.

In the first of these we have a problem which is never impossible and for which there is never more than one solution, while the second yields a wealth of special cases which classes generally will discuss with enthusiasm. Before leaving these two loci it is well to bring out the fact that, whereas two conditions are necessary and sufficient to determine a straight line, two conditions are necessary but not always sufficient to determine a point.

Then, as occasion offers, the following loci may be brought up for discussion:

No. 3. The locus of a point equidistant from two parallels is a third line, parallel to the two given lines, and midway between them.

No. 4. The locus of a point at a given distance from a given line is a system of two lines, parallel to the given line and at the given distance on each side of it.

No. 5. The locus of a point at a given distance from a given circle is a system of two circles, concentric with the given circle, and having for their radii respectively the sum and difference of the radius of the given circle and the given distance.

A number of problems will suggest themselves, which can be solved by different combinations of these five loci, and which afford excellent material to give as unprepared work in odd minutes, or for the sake of variety.

Thus far we have dealt only with loci which follow as corollaries

from the definitions. By the time, however, that the class reach in the regular order of the course the theorems on the perpendicular bisector of a line and on the bisector of an angle, they will be prepared to understand:

(1) The difference between a partial locus and a complete locus;

(2) That every locus theorem is a concise statement of an ordinary theorem and its converse; and therefore

(3) That, when a locus theorem calls for proof, it is necessary to prove, not only that any point in the proposed locus meets the given conditions, but also that any point not in it does not satisfy those conditions; and, finally,

(4) That when the character of a locus is not at once evident, it can be discovered by locating a sufficient number of points.

And before we leave these theorems they are ready to accept and to appreciate the second definition of locus, *viz.*:

"A geometric locus is the position of all points that fulfill a given condition."

From this time on, the development of the subject must depend on circumstances. It is well, especially at first, not to give much of this material in a single lesson, and it is also well not to let the subject drop entirely for very long at a time. Of course the more practice the student can have in the investigation and the use of loci the better; but he is now in possession of the field, as incidentally he has learned some valuable lessons as to what constitutes a thorough discussion of a mathematical problem.

COUNTRY LACKS TIN DEPOSITS.

Tin is one of the minerals in workable deposits of which the United States is lacking. Our production in 1910 was valued at only $23,447, according to the United States *Geological Survey*, while our importations were worth $33,913,255. We need one or two large tin mines.

NEW TYPE OF OIL.

The oil from the large well recently drilled by the Myles Mineral Company at Pine Prairie, La., is remarkable, according to an analysis made by the United States Geological Survey, in that it contains no asphalt, gasoline, or paraffin wax. The crude product contains a very large percentage of illuminating oil. In composition the oil stands about halfway between the oil of the Gulf field and that of the Caddo field.

The well has been connected with pipe lines and loading rack on the Rock Island Railroad, from which shipments are now being made. Eight other wells are in process of drilling.

APPLIED BOTANY.

By George A. Works,
Instructor in Agricultural Education, University of Wisconsin.

The phases of this course in botany which are here outlined are the results of six years' use of the material in an effort to develop a course adapted to the interests and needs of the constituency of a high school in a community which is essentially rural. The outline is not offered as a complete course in botany, as only what may be termed the "applicable" portions of the work are given.

In the work on seeds a study was made of the following topics: selection, identification, proper care, judging of quality, and germination tests that could be used under ordinary farm and home conditions. The work was centered around a more or less intensive study of corn with comparative consideration of other seeds. It was not thought sufficient that the pupil should merely watch the germination of a miscellaneous collection of kernels of corn, but he was required to make ear tests according to the most approved methods. Conditions necessary for germination found many applications in farm and garden practice. A limited study was made of the food constituents of some of the more common seeds, which study terminated in a consideration of their use for human food as well as for lower animals. This laid the basis for the development of some idea of the importance of the great cereal crops.

Because of the increasing importance of noxious weeds, the pupils were familiarized with the common local species. This identification was accompanied by a study of the botanical peculiarities of the plants which made them so objectionable, such as methods of seed distribution and vegetative reproduction. This study was accompanied by a consideration of the methods of eradication. Members of this group furnish some of the best material for a study of seed and fruit distribution.

In the work on stems a careful study was made of some of the practical applications in agriculture and horticulture in connection with such topics as vegetative propagation, transplanting, pruning and proper methods of treating tree injuries.

If time permitted attention was given to commercial products derived from stems such as turpentine, resin, corn products, camphor and rubber. A parallel line of work was conducted in connection with the study of roots.

In addition to the various economic phases of such character as has been suggested, certain subjects were considered of sufficient importance to justify a more detailed consideration. These topics included a more or less intensive study of a few farm and garden plants; for example, corn, clover, potato, and the oat. These are only suggestive as in a different section of the country other plants may be better suited to class needs.

A little work was done in elementary forestry mainly to familiarize the pupil with some of the common native trees, methods of forest preservation, and the general problems of forest conservation. It was hoped by this means to put the students in a position to read about the problem with a reasonable degree of intelligence.

An effort was made to give the pupils an idea of plant breeding and its significance in advancing agricultural and horticultural conditions. In Wisconsin marked advances have been made in the development of varieties of corn suited to its climatic and soil conditions and hence the work was centered around this phase of the problem, although not limited to it. The technical nature of the subject of breeding makes an intensive consideration out of place with secondary school students.

Three or four weeks were devoted to elementary bacteriology. The following topics are indicative of the character of the work: occurrence, conditions favorable for growth and some of the results of the growth of bacteria. Experimental work was used to illustrate the topics as far as possible. Some of the experiments that proved especially satisfactory were tests to show the presence of bacteria in the air under varying conditions, to detect them in the soil, water, milk, and on the body. This work was followed by a study of the significance of bacteria in fermentation processes, decay, nitrogen fixation, and in a very elementary way their relation to some of the common diseases found among the lower animals as well as those of human beings. Sterilization and disinfection were illustrated, also some of the more common methods employed in the household to protect food materials against bacterial action.

Because of local conditions a study was made of blue-green algae in their relation to pollution of water supply. The water for the city is drawn from a small lake near by, and abundance of illustrative material could be obtained by straining the water as it flowed from a tap in the laboratory. The study of the

structure of the water system together with a consideration of the conditions favorable for the growth of blue-greens and the knowledge the pupils already had of bacteria put them in a position to understand the danger of using the water. Methods of treating such water so that it might be used for drinking purposes without danger were taught. This portion of the course was found very helpful in giving pupils an intelligent attitude toward some of the problems of personal hygiene and of home and public sanitation. Such work properly handled will lay a foundation for intelligent community ideals in sanitation and for proper coöperation with civic authorities in case of outbreaks of communicable diseases. This attitude is sadly lacking in the average American community. Throughout this work the "pure" phases of the subject were determined largely by the practical applications which were to follow. In fact, a consistent effort was made to select such material for study as had a bearing upon the community life and which had a first-hand interest to the pupil.

The method of treatment of yeasts resembled materially that described for bacteria. The usefulness of the yeasts is sufficient to justify a somewhat detailed consideration.

The fungi offer such an abundance of material that care had to be exercised in the selection. The forms which we found best adapted to our purposes were the following:

1. The mildews which were approached through a study of grape mildew. Material was easy to obtain and is sufficiently large to be handled in a satisfactory manner. A study of the life history of this form puts the pupil in a position to understand the significance of the spraying.

2. Mucor served as the basis of the work with the molds that are of importance in the household. The study of the life history and conditions favorable for growth and reproduction enables the pupil to appreciate intelligently the means of preserving food from the action of molds by drying, use of chemical preservatives, low temperature, and high temperature followed by hermetical sealing.

3. A careful study was made of the smuts and rusts of grains. A method of treatment similar to that indicated for mildews served as a basis for a discussion of the methods of treating grain smut. The attention of the students was directed to the efforts that are being made to develop rust-resistant grains.

4. A brief study of the higher fungi was made and the economic importance of the bracket fungi and the mushrooms were considered.

As has been previously stated, throughout the course an effort was made so to handle the work in "pure" botany that the student was able intelligently to connect it with the applications which surround him on all sides. To permit the work to be a consideration of so-called practical work without the proper scientific basis would entirely defeat the purpose of such a course.

The emphasis that was placed upon the indicated phases of the work meant that there was necessarily considerable elimination of material that is usually found in the botany course. This elimination was made to a considerable extent by decreasing the number of plant forms studied. The average course is developed so as to show as complete an evolutionary series as possible. No such effort was made in this course. As a result the pupils had definite ideas of those forms which were studied instead of being bewildered by almost numberless studies of forms the great majority of which most of the pupils will never even hear by name outside of the classroom. The development of an evolutionary series by the plant kingdom is an interesting and valuable exercise in its place but that place is not in a freshman or sophomore class in high school botany.

Botany perhaps more than any other high school science has suffered from an overburden of scientific terms. Teachers have often deceived themselves by thinking pupils were making real progress in the subject because they were learning new terms. They have mistaken the shadow for the substance. Often a pupil learns the term without mastering the idea. Pupils should not be allowed to grope about using bungling expressions because of lack of proper technical terms: every scientific term essential for progress should be mastered. But we found that it was possible to reduce greatly the number of terms that are used in the ordinary text in botany. This together with the use of English words or compounds instead of foreign derivatives has materially simplified the terminology problem.

This course is not offered as one that is above criticism nor as one that should be adopted *in toto* by another school. It is merely an effort to put such a content into a high school course in botany as is adapted to the needs and interest of high school students to the end that botany may accomplish more fully

and completely the purposes it should serve in a secondary school made up of people who for the most part will receive no further school training in the subject. It is trite to say that there is a public demand for better preparation of the young people in our schools for the conditions under which they are to live. The science subjects are especially subjected to this constantly increasing pressure. Especially is this true in the case of botany as a result of the great wave of interest in agricultural education which is now sweeping across the country. In many schools it is being displaced by agriculture. This is a mistake. The kind of agriculture which should be taught in the American high school should not supersede botany nor the other basic sciences but should accompany them and be based upon them. To prevent this substitution the teachers of botany have before them the problem of reorganizing their work in this subject so that it may be built around a core of economic material. The course that has been outlined is but one of a considerable number of attempts that are now being made to attain this end. There is further need of experimental work of this character. High school teachers should assert their independence of the miniature college course in botany because such work is not adapted to the economic and educational needs of their pupils.

The courses that we now find are the logical result of the rapid development of secondary school botany during the last twenty-five years. The most natural thing to be done was to put in the organized material of the college course because teachers were best prepared to handle it and text-books were based on such courses. But the stage is passed when such work should dominate the high school. The fact that teachers are doing so much work of an experimental nature in this field indicates that they are awakening to a realization of this condition. The securing of proper teaching of botany and other high school sciences as well is not a problem that can be solved by the sporadic efforts of secondary school instructors. Superintendents and principals must lend their aid or the work will lack the necessary continuity because of the limited tenure of office of the average high school instructor. But there is even a greater possibility for assistance on the part of those responsible for the administration of courses of study. They may turn to the institutions preparing teachers and justly demand that these people shall have a more adequate preparation for

their work. Such preparation will mean that the prospective teacher as a part of his scientific training will have work that will fit him to seek out and organize material adapted to the high school pupils' interests and needs.

Those who undertake work of this character may be certain that their efforts will be subject to criticism by those who mistake or misunderstand its aims. The following quotation is illustrative of the point in question:

"A radical phase of the movement toward economic biology appears in demand for lessons on all sorts of topics bearing on horticulture and farming, from injurious insects to plant breeding. Doubtless in some country high schools a good deal of such work can be made thoroughly interesting and profitable. And in any schools such matter, in very moderate amounts, may properly be assigned for supplementary reading. Leaving out business and other technical courses, however, when one begins to make economic considerations the measure of educational values he begins to pile up absurdities. As soon as the teachers of geography, history and geometry are willing to bend most of their respective efforts toward instruction regarding commercial routes, the alternation of periods of activity and depression in the world's business, and mensuration, it will be time for biology teachers to consider favorably corresponding pseudo-utilitarian innovations. But if the most valuable crop that any country can produce is intelligent men it must follow that any kind of study which is preëminently suited to cultivate habits of careful observation and orderly thinking in school children is especially important."

The writer quite evidently loses sight of the fact that if these habits of "careful observation and orderly thinking," which all concede are highly desirable, are to be applied in the after life of the pupil they must not only be formed during the period of youth but they must be connected with the problems of social interest which are in a large measure either directly or indirectly of an economic character. This habit formed during the high school period means that in the majority of cases the result will be not merely a high school pupil in botany but one who will be a lifelong student of these problems which so vitally affect human happiness and social progress.

FINAL REPORT OF THE COMMITTEE ON METHODS OF TESTING RESULTS OF TEACHING PHYSIOGRAPHY.

The committee was appointed at the Chicago meeting of the Central Association of Science and Mathematics Teachers, held in November, 1909. A preliminary report was made at the Cleveland meeting in 1910, and a report of progress at the meeting in Chicago in 1911.

We find that the conditions under which physiography is taught vary greatly. In most of the high schools it is given in the first year; but in some in the second year, and in still others in the third and fourth years. Many schools have courses of only a half year, while others have a full year. In treatment some emphasize the atmosphere and climate, others the land.

We devised three tests and asked teachers in many states to coöperate with us in giving them, to grade the papers and to send them to us. We also asked for a written report on the examination papers and a statement of the conditions under which physiography is taught. The replies were most cordial and gratifying. From the nature of the case the tests could be given only at the end of the course. This is a busy time for teachers and pupils. A number of schools were about to close when our request reached them. Some of the teachers volunteered to give tests next year; others, for various reasons could not give them. We have results from twelve schools:

Rochester, N. Y., East High School; Ft. Wayne, Ind., High and Manual Training School; Ann Arbor, Mich., High School; Detroit, Mich., Central High School; Highland Park, Ill., Deerfield-Shields Township High School; Chicago, Ill.: Lewis Institute, Austin High School, Farragut High School, Lake View High School, Tuley High School; Rockford, Ill., High School; Portland, Ore., Washington High School.

A few of these schools were not able to give all of the tests.

Test No. 1 consists of questions on the wind belts of the earth. It is the form of test usually given. It is given here to show that our teaching should emphasize the manner in which physiographic conditions control life, and to show how they have influenced history.

Test No. 2 is the interpretation of two typical weather maps. We believe that the effects of weather and climate are so great not only on agriculture, but also on trade and

finance that the study of them becomes imperative. Our government spends large amounts of money in maintaining the weather bureau and in making and distributing the maps; most of the daily papers publish forecasts of the weather; we are therefore led to the conclusion that every educated person should know the principles that govern the weather and should be able to interpret the map. This test is not primarily a test of memory.

Test No. 3 consists of eight pictures. The problem for each is to classify the land form and to explain by what physiographic process the results were produced. The series goes from very simple to very complex phenomena. In this way we are able to find the upper limit of the ability of the pupils. The gradation is not in the numerical order of the pictures. As the pictures have not been seen before, the test involves more than memory.

The accompanying table shows the results of the tests.

School No.	Test No. 1			Test No. 2			Test No. 3			Total—3 Tests		
	No. Taking	No. Passing	% Passing	No. Taking	No. Passing	% Passing	No. Taking	No. Passing	% Passing	No. Taking	No. Passing	% Passing
1	26	20	77	28	21	75	26	23	88	80	64	80
2	43	28	65	43	33	77	43	28	65	129	89	69
3	32	19	59	34	25	74	34	22	65	100	66	66
4	0	0	0	52	32	62	64	42	66	116	74	64
5	0	0	0	28	15	54	28	20	75	56	35	63
6	23	17	74	23	13	57	23	3	13	69	33	48
7	38	12	32	38	19	50	38	22	58	114	53	46
8	26	8	31	26	20	77	26	2	8	78	30	38
9	6	1	17	5	3	60	6	2	33	17	6	35
10	75	24	32	0	0	0	0	0	0	75	24	32
11	18	5	28	22	5	23	20	6	30	60	16	27
12	30	4	13	30	5	17	28	9	32	88	18	20
Total	317	138	44	329	191	58	336	179	53	984	508	54

The work shown in the table is given in different years of the high school. In Rochester, N. Y., it is in the third and fourth years; Ann Arbor, Mich., second year; Ft. Wayne,

Ind., second year; Rockford, Ill., second year. The other schools give it in the first year. From the grades in the table one could not pick out the schools giving the upper grade work. The papers from the upper years show a maturity in judgment and in expression not found in the first year. There does not seem to be however, a corresponding increase in accuracy with advancing years in the school.

Since the grading by teachers is variable, we have reviewed the papers submitted and have graded them from all of the schools on the same basis. The number passing is as found by the committee and not necessarily as reported by the teacher of the class.

We regret we could not extend the tests so as to cover other topics. For example, the interpretation of topographic maps lends itself to such tests. We consider it the duty of American citizens to be able to use the contour maps which the government generously provides at a very small cost. Where maps of the home region have been made, so they may be used in the field, the teaching of the use of these maps is less difficult than elsewhere. Other topics suitable for such tests are wind work; the distribution of plant and animal life in the home state and elsewhere; the influence of river valleys on the density of population; etc.

We should have been pleased to find higher percentages than appear in the table. In passing judgment we must remember that the tests were set by teachers not connected with the schools in which they were given; that they are of somewhat different nature than those to which the pupils were accustomed; and that they were given at the end of the year, when the program is crowded. They were given moreover to exemplify methods of testing rather than to ascertain results accomplished.

In case two or more schools are in the same city we find as great a variation of results as exists between schools in different cities. This holds true at least for the schools named in our report.

A low grade in a school does not necessarily mean poor work in that school. The school may emphasize topics not included in our tests. However, as the tests are in three broad divisions of the subject we believe the averages show fairly well the work that is being done.

Test No. 1 was taken by 317 pupils; No. 2 by 329; No. 3

by 336. These represent a much larger number for they are sample classes from the twelve schools. Counting the subdivisions of the questions we have for test No. 1, 4,438 answers; for No. 2, 2,632; for No. 3, 7,392; a total of 14,462 answers. Following are the three tests:

Test No. 1.

Time for the test, one recitation period.

1. In what belts of wind and calm are the deserts of the earth? Explain the lack of rainfall in each belt.
2. Mexico and the Sahara are situated in the same belt of winds. The eastern slope of the Mexican plateau is covered with forest. The Sahara is a desert. Explain.
3. The Island of Madagascar (latitude about 20° South) has forests on its eastern side but on its western side there are grass lands. Explain.
4. The Island of Jamaica (latitude 18° North) has mountains running from east to west, and reaching altitudes of several thousand feet above sea level.
    a. What vegetation would you expect on the north side of this island?
    b. What vegetation would you expect on its south side?

5. *a.* In what belt of winds do you live?
    b. Explain the rainfall in the part of this belt in which you live.

6. *a.* In what belt of natural vegetation do you live?
    b. What are the present great occupations of the people of this belt?
    c. What are the reasons for people engaging in these occupations?

7. *a.* What were the early occupations of the people of the town in which you live?
    b. Why did the town grow up just where it is?
    c. What are the present great industries in this town?
    d. What are the reasons for the growth of these industries at this place?

Test No. 2.

Forecasting the Weather.

Time for the test, twenty minutes.

Map No. 1.

Forecast the weather for Chicago, Ill., for 24 hours from the time of the observations shown on this map.

Let the forecast include:

a. Temperature—What changes of temperature will there be in the 24 hours?
b. Sky—What changes in the clearness or cloudiness of the sky will there be in the 24 hours?
c. During what part of the 24 hours will there be rainfall, if any?
d. Wind—From what direction will the wind come during the 24 hours?

LOW
LOW
HIGH
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ORE.
CAL.
NEV.
IDAHO
MONT.
WYO.
UTAH
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COLO.
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OKLA.
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MINN.
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ARK.
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OHIO
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TENN.
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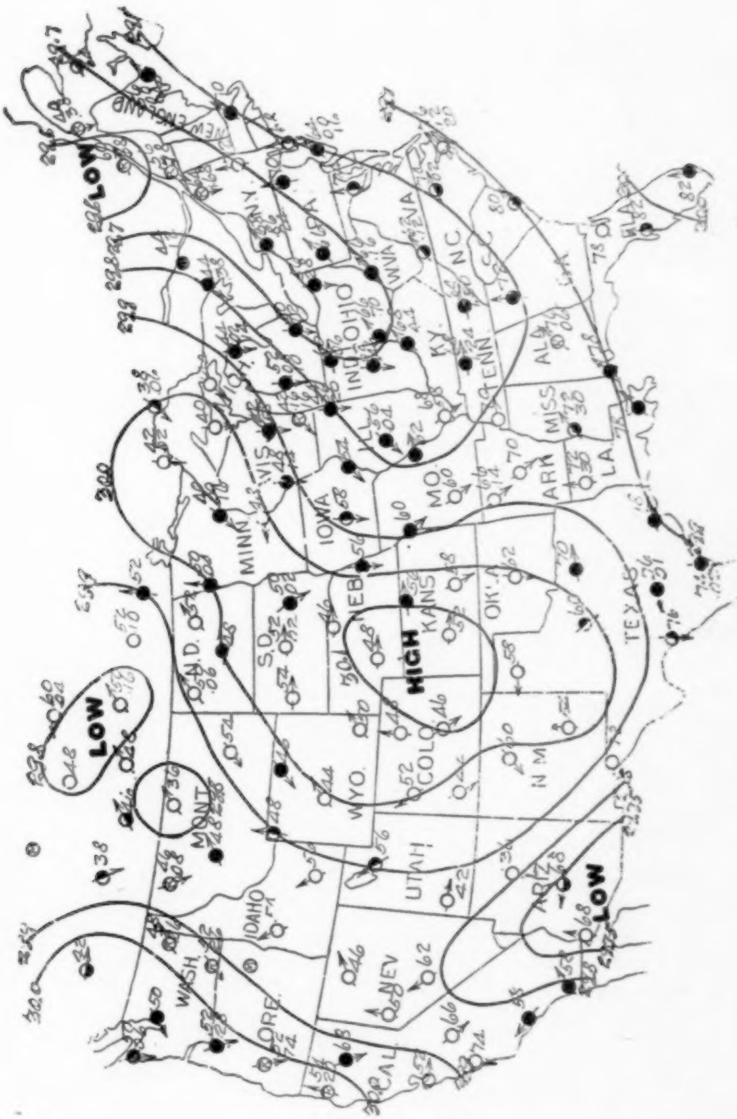
N.C.
VA.
W.VA.
PA.
NEW ENGLAND

Map No. 1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Map No. 2

Map No. 2.

Forecast the weather for Chicago, Ill., for 24 hours from the time of the observations shown on this map.

Let the forecast include:

a. **Temperature—What changes of temperature will there be in the 24 hours?**

b. **Sky—What changes in the clearness or cloudiness of the sky will there be in the 24 hours?**

c. **During what part of the 24 hours will there be rainfall, if any?**

d. **Wind—From what direction will the wind come during the 24 hours?**

Testing No. 3.

Time for the test, one recitation period.

To tell what the pictures show about physiographic processes and results.

For pictures number 1 to number 7, inclusive, answer questions 1, 2, and 3.

1. **What physiographic features are shown by this picture?**
2. **What agents produced these features?**
3. **By what processes or ways were these features produced?**

For picture number 8 answer only the following:

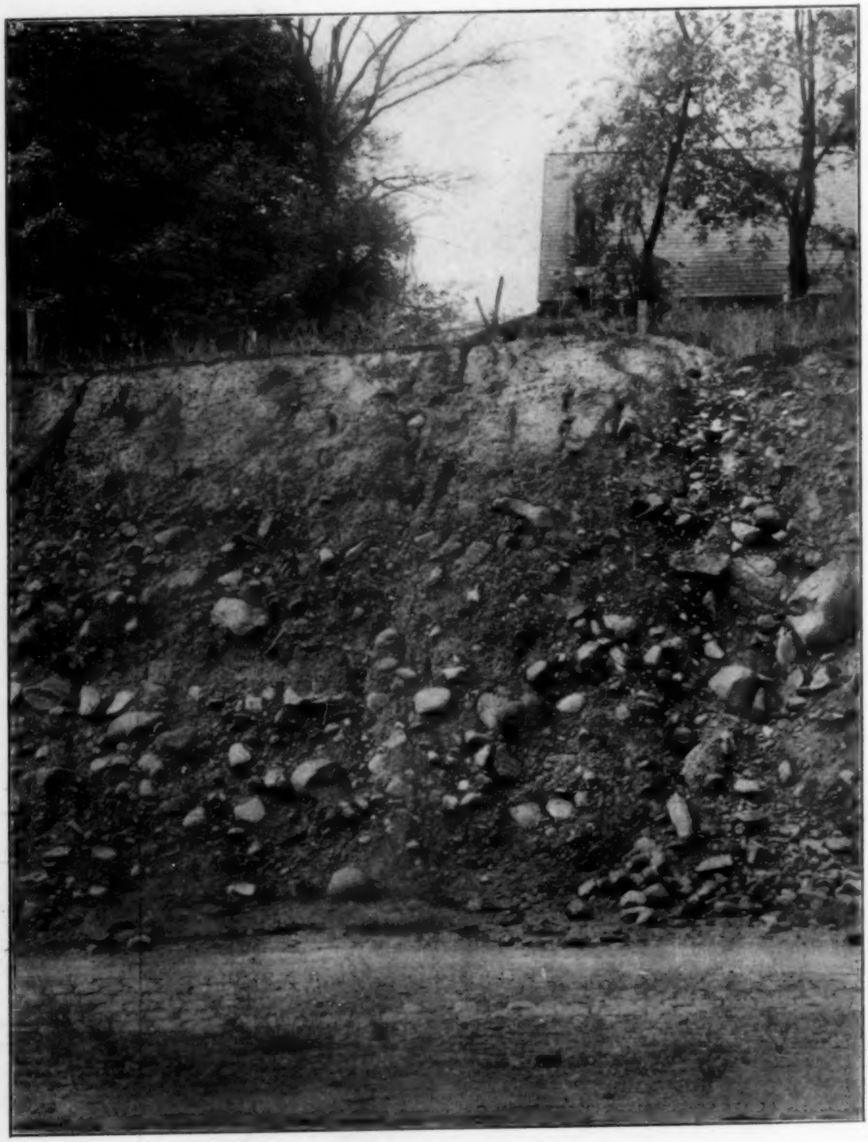
1. **Tell the changes which have taken place on this coast in the order in which they occurred.**

PICTURE No. 1.

PICTURE No. 2.

PICTURE No. 3.

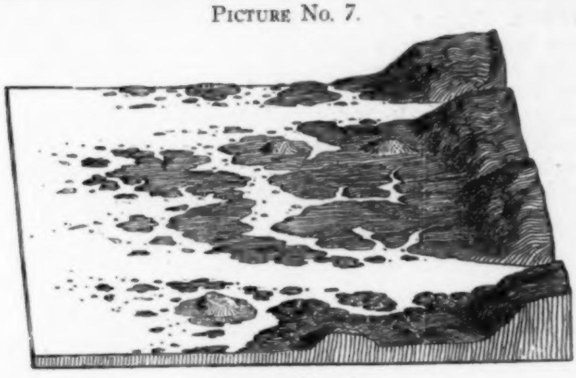
PICTURE No. 4.



PICTURE NO. 5.

PICTURE No. 6.

PICTURE No. 7.



PICTURE No. 8.

[The plates for the weather maps were kindly loaned us by the Chicago office of the U. S. Weather Bureau.

The cuts for the pictures were loaned by their various owners, to whom we are indebted for the service. The pictures are from the following sources:

Picture No. 1, Geol. Surv. Wis., Bul. VIII, series 2, facing p. 113, fig. 1.

Picture No. 2, Elements of Geology by Blackwelder and Barrows, fig. 187. Amer. Book Co.

Pictures No. 3 and 4, Hamburg-American Line.

Picture No. 5, Geol. Surv. N. J., vol. V, facing p. 4, plate 1.

Picture No. 6, Blackwelder and Barrows' Geol., fig. 231.

Picture No. 7, Geol. Surv. Wis., Bul. VIII, series 2, facing p. 24, fig. 2.

Picture No. 8, Davis, Elements of Phys. Geog., fig. 169. Ginn & Co.]

In closing this report we wish to refer to other methods of testing which may be found in "School Science and Mathematics, Vol. XI, p. 315, (1911); and in the "Journal of Geography," Vol. X, p. 176, (1912)].

JAMES H. SMITH,
ZONIA BABER,
CHARLES EMERSON PEET,
Committee.

ANTIPODAL LABORATORY DIRECTIONS.

The directions here given have been found extra helpful to the author, Mr. S. W. Hockett of Moorhead, Minn. He has had them posted conspicuously in his laboratory and has found that their very uniqueness has accomplished the purpose for which they were devised.

"Cleanliness (not carelessness)—is next to godliness"—Digest well.

To "evaporate to dryness" all your funds, leave heating substances unattended.

To *form* "habits of disorder," keep apparatus disarranged in drawers of desk.

To precipitate the disapproval of instructor, set up botchy, patchy apparatus, or let water stand on desks, or acids on books.

Haste makes good waste at all temperatures, both of supplies and credits.

Use plenty of c. p. Standard oil—(elbow grease)—in removing impurities; it attacks dirt vigorously, and combines to produce good dividends.

Don't lay stoppers down on desks, until after replacing them in proper bottles.

Don't let your burner "strike back," unless you want a new one (to pay for).

To heat water without burning it, place it inside—not on outside—of vessel.

To break t. t.'s, run wire T. T. cleaners through bottles, or clamp tightly and heat (especially above the level of contained liquid).

To break a beaker, heat with water on the outside. (Drop it in emergency.)

To break a flask, cork tightly with unpliable stoppers, or strike it lightly against the burner (or against some fixed body, when filled).

To break an evaporating dish, pour cold water in it while hot.

To break a U-tube, hammer it on the desk, or try to pulverize a solid in it.

To crack reagent bottles, twist or hammer stoppers in tight.

To break a clamp, screw it up with all your might.

To destroy labels, shelves or table tops, let fluids run down sides of bottles.

Use precaution and care only where you have not acquired the unconscious habit and tendency to manipulate everything carefully, cautiously, and with self-confidence.

PROBLEM DEPARTMENT.

By E. L. Brown,
Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

292. *Selected.*

$2x^4 - 4x^3 + Kx^2 + 41x - 30 = 0$ has the sum of three of its roots equal to zero. Find all the roots.

Solution by H. H. Seidell, St. Louis, Mo., and Eugene M. Dow, Brighton, Mass.

The sum of all the roots $= -\dfrac{-4}{2} = 2$, hence one root is 2.

Substitute $x=2$ in given equation and obtain

$$4K+52=0. \quad \therefore K=-13.$$

$\therefore 2x^4-4x^3-13x^2+41x-30=0. \qquad (1)$

By trial we find that -3 is a root of (1).

$\therefore (x-2)(x+3)(2x^2-6x+5)=0.$

Hence, roots are $2, -3, \dfrac{3\pm i}{2}$.

293. *Proposed by E. B. Escott, Ann Arbor, Mich.*

Solve $(a^2 - b^2)x^2 = 4b^2(x^2+1)(x^2-x+1)$

Solution by John M. Gallagher, Boston, Mass., and L. E. A. Ling, La Grange, Ill.

I. We have $(m^2-1)x^2=4(x^2+1)^2-4x(x^2+1)$, where $m = a/b$,

or $4(x^2+1)^2-4x(x^2+1)+x^2=m^2x^2$.

$\therefore 2(x^2+1)-x=\pm mx;$

i. e. $2x^2-x(1\mp m)+2=0.$

Whence $x=\dfrac{(1\mp m)\pm\sqrt{(1\mp m)^2-16}}{4};$

i. e. $x=\left(a+b\pm\sqrt{a^2+2ab-15b^2}\right)/4b,$

and $x=\left(-a+b\pm\sqrt{a^2-2ab-15b^2}\right)/4b.$

II. *Solution by Proposer.*

Divide by $(x^2+1)^2$. We have

$$(a^2-b^2)\frac{x^2}{(x^2+1)^2}=4b^2\left(1-\frac{x}{x^2+1}\right)$$

Solving as a quadratic in $\dfrac{x}{x^2+1}$, we find

$$\frac{x}{x^2+1}=\frac{2b}{a+b} \text{ and } -\frac{2b}{a-b}.$$

$\therefore x=\left(a+b\pm\sqrt{a^2+2ab-15b^2}\right)/4b$ and $\left(-a+b\pm\sqrt{a^2-2ab-15b^2}\right)/4b.$

296. *Proposed by Nelson L. Roray, Metuchen, N. J.*

If O, O′ be any isogonal conjugate points, with respect to the triangle ABC, and if OL, O′L′ be perpendicular to BC; OM, O′M′ perpendicular to AC; and ON, O′N′ perpendicular to AB; show that the six points L, M, N, L′, M′, N′, are concyclic with mid-point of OO′ and that MN is

perpendicular to AO′. (Lachlan's Modern Pure Geometry, p. 56, ex. 2.)

Solution by Elmer Schuyler, Brooklyn, N. Y., and by the Proposer.

Let AO and AO′ be the isogonal conjugate rays with respect to the angle BAC, and AO′ lie within the angle BAO.

Then $\triangle$AON is similar to $\triangle$AO′M′ and $\triangle$AOM is similar to $\triangle$AO′N′.

$$\therefore \frac{ON}{O'M'} = \frac{OA}{O'A} \text{ and } \frac{OM}{O'N'} = \frac{AO}{O'A}.$$

$$\therefore ON \cdot O'N' = O'M' \cdot OM.$$

Similarly $ON \cdot O'N' = OL \cdot O'L'$.......(1)

Also from similar triangles BO′N′ and BOL,

$$\text{we have } \frac{BN'}{BL} = \frac{O'N'}{OL}.$$

From similar triangles BON and BO′L′

$$\text{we have } \frac{BN}{BL'} = \frac{ON}{O'L'}$$

$$\therefore \frac{BN \cdot BN'}{BL \cdot BL'} = \frac{ON \cdot O'N'}{O'L' \cdot OL}$$

$$= 1 \text{......From (1)}$$

$\therefore BN \cdot BN' = BL \cdot BL'$

$\therefore$ L, L′, N′ and N are concyclic.

Similarly L, L′, M′ and M are concyclic.

$\therefore$ L, L′, M, M′, N and N′ are concyclic.

Let S be the mid-point of OO′.

O′OLL′ is a trapezoid. $\therefore$ perpendicular bisector of LL′ passes through S, also perpendicular bisector of N′N and of M′M.

$\therefore$ S is center of circle passing through L, L′, M, M′, N and N′.

Also A, N, M and O are concyclic. $\therefore \angle ONM = \angle OAM = \angle NAO'$.

$\therefore \angle NAO' + \angle ANM = 90^\circ$ and $MN \perp AO'$.

Geometry.

294. *Proposed by A. C. Smith, Denver, Colo.*

If s be the semiperimeter of a triangle, r_1, r_2, r_3 the radii of its escribed circles prove that

$$s^2 = r_1r_2 + r_2r_3 + r_3r_1.$$

Solution by A. M. Harding, Fayetteville, Ark., and G. I. Hopkins, Manchester, N. H.

Let r_1 be the radius of the circle escribed to the side a, r_2 that for b, and r_3 that for c. Then if $\triangle$ denote the area of the triangle,

$$r_1b + r_1c - r_1a = 2\triangle.$$

$$\therefore r_1 = \frac{\triangle}{s-a}.$$

Likewise, $r_2 = \dfrac{\triangle}{s-b}$ and $r_3 = \dfrac{\triangle}{s-c}$.

$$\therefore r_1r_2r_3 = \frac{\triangle^3}{(s-a)(s-b)(s-c)} = \triangle . s.$$

$$\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} = \frac{s}{\triangle}. \quad \therefore r_1r_2 + r_2r_3 + r_3r_1 = \frac{s}{\triangle} \cdot r_1r_2r_3.$$

$\therefore r_1r_2 + r_2r_3 + r_3r_1 = s^2.$

295. *Proposed by I. N. Warner, Plattesville, Wis.*

If from any point A on a circle the chords AB, AC are drawn so as to trisect the area of circle, find angle between the chords.

I. *Solution by R. M. Mathews, Chicago, Ill., and E. E. Whitford, New York City.*

Let AOD be the diameter from A, O the center and r the radius of the circle. Let $x=\angle BOD=\angle BAC$.

$\triangle AOB=\frac{1}{2}r^2 \sin x$.

Sector $BOD=\frac{1}{2}r^2x$, (x expressed in radians).

$\therefore BAC=r^2 \sin x+r^2x=\frac{1}{3}\pi r^2$.

$\therefore x+\sin x-\frac{\pi}{3}=0$.

$\therefore x=.5362674$ radians$=30^\circ\ 43'\ 33''$.

II. *Solution by Nelson R. Roray, Metuchen, N. J.*

Let r be the radius of the circle, a the angle between the chords, y the chord of the arc of a, and x the chord of the arc of $\frac{a}{2}$. Evidently the diameter from the vertex of a bisects a.

It is easy to see that $x=2r\sin\frac{a}{2}$, $y=2r\sin a$. Hence by Huygen's Formula the length of the arc of a is

$$\tfrac{1}{3}\left(16r\sin\frac{a}{2}-2r\sin a\right).$$

$\therefore$ Area of the sector whose angle is $2a$ is

$$\tfrac{1}{3}\left(8r^2\sin\frac{a}{2}-r^2\sin a\right).$$

Also the area of the part of the circle included between the chords is easily shown to be

$$\tfrac{1}{3}\left(8r^2\sin\frac{a}{2}-r^2\sin a\right)+r^2\sin a.$$

$\therefore$ We have $2\sin a+8\sin\frac{a}{2}=\pi$

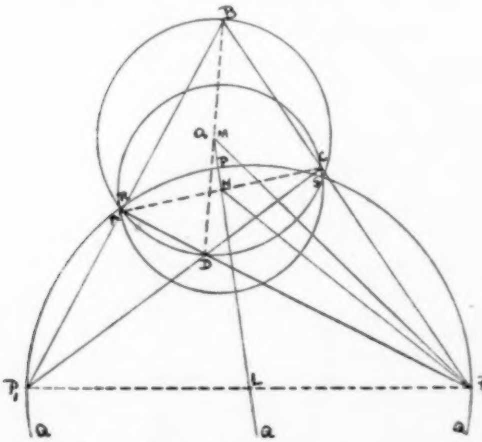
Whence $a>30^\circ\ 43'<30^\circ\ 44'$.

284. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Given the three diagonals of an inscriptible quadrilateral, to construct the quadrilateral.

If the internal diagonals are 10 and 12 and the external is 20, what are the lengths of the sides?

NOTE.—It is assumed that the radius of the circumcircle is given. In the numerical example let $r=7$.—EDITOR.



Solution by the Editor.

Let ABCD be the required quadrilateral, AC and BD the internal diagonals, P_1P_2 the external diagonal, and O the center of the circumscribed circle. Construct circles on the three diagonals as diameters, and let M, N, L be their centers.

Let r_1=MB, r_2=NC, $P_1L=r_3$.

Divide MN internally at P and externally at Q so that

$$MP/PN=MQ/QN=r_1/r_2.$$

On PQ as a diameter describe a circle. This circle is the locus of all points whose distances from M and N are in the ratio of r_1 to r_2, and, therefore, passes through the points R and S, points in which circles M and N intersect.

Since triangles P_1AC and P_1BD are similar, their homologous lines are proportional. P_1M and P_1N are medians of these triangles.

$$\therefore\ P_1M/P_1N=r_1/r_2.$$

$$\text{Similarly, } P_2M/P_2N=r_1/r_2.$$

$\therefore$ Circle L passes through the points P_1 and P_2.

Since the circles on the three diagonals of a complete quadrilateral as diameters are coaxal, the circle on P_1P_2 as a diameter passes through the points R and S.

$\therefore$ The circles on PQ and P_1P_2 as diameters coincide and $PQ=P_1P_2$.

Now $QM/QN=r_1/r_2$ and $PM/PN=r_1/r_2$.

$$\therefore\ \frac{QM}{QM-QN}=\frac{QM}{MN}=\frac{r_1}{r_1-r_2},\text{ or } QM=\frac{r_1}{r_1-r_2}\cdot MN.$$

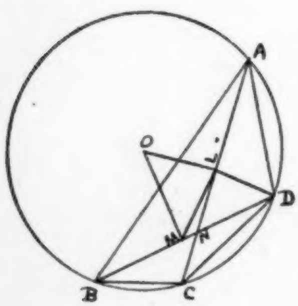
$$\text{Also } \frac{PM}{PM+PN}=\frac{PM}{MN}=\frac{r_1}{r_1+r_2},\text{ or } PM=\frac{r_1}{r_1+r_2}\,MN.$$

$$\therefore\ QM-PM=QP=2r_3=MN\left[\frac{r_1}{r_1-r_2}-\frac{r_1}{r_1+r_2}\right]$$

$$\therefore\ MN=\frac{r_3(r_1^2-r_2^2)}{r_1r_2}.$$

Since AB and BD are given, their distances from O can be found and hence the sides of the triangle OMN determined.

Hence, to construct the quadrilateral, draw the diagonal BD and join its mid-point M to O; with ON and MN as radii determine the point N; join ON and through N draw AC perpendicular to ON. A, B, C, D are the vertices of the required inscribed quadrilateral.



Let L be the mid-point of AC, M of BD, and N the point of intersection of the two diagonals. Join L to M and L to D.

Now $ML=\frac{r_3(r_1^2-r_2^2)}{r_1r_2}=3.667$.

In the right triangle OLA, OA=7, AL=6, and hence OL=3.606.

Similarly in right triangle OBM, OB=7, BM=5, and hence OM=4.899.

Now having the sides of the triangle OLM, we easily find

$\angle OLM=84°41'25''$ and $\angle OML=47°7'49''$.

$\therefore \angle MLC=5°18'35''$ and $\angle LMD=42°52'11''$.

In triangle LMD, LM=3.667, MD=5, and $\angle LMD=42°52'11''$.

$\therefore$ LD=3.399, $\angle LDM=47°13'19''$, and $\angle MLD=89°54'30''$.

In triangle ALD, AL=6, LD=3.399 and $\angle ALD=95°24'25''$.

$\therefore$ AD=7.169, $\angle LAD=28°9'53''$, and $\angle LDA=56°25'42''$.

In triangle ADB, AD=7.169, BD=10, $\angle ADB=103°39'1''$.

$\therefore$ AB=13.582.

In triangle CLD, $\angle CLD=84°35'3''$, LC=6, and LD=3.399.

$\therefore$ CD=6.614 and $\angle LDC=64°38'41''$.

In triangle BDC, $\angle BDC=\angle LDC-\angle LDM=17°25'22''$, BD=10, CD=6.614. $\therefore$ BC=4.191.

$\therefore$ AB=13.582, BC=4.191, CD=6.614, DA=7.169.

CREDIT FOR SOLUTIONS RECEIVED.

277. Benjamin E. Chiu. (1)
284. E. L. Brown. (1)
287. Benjamin E. Chiu, Effie Morse. (2)
288. Benjamin E. Chiu. (1)
292. T. M. Blakslee, W. S. Cawthorn, Isaac Doughton, E. M. Dow, J. M. Gallagher, F. W. Gentleman, A. M. Harding, R. M. Mathews, Nelson L. Roray, W. P. Russell, H. H. Seidell, C. H. Stoutenburgh, G. M. Weld, E. E. Whitford, D. T. Wilson, Elmer Schuyler. (16)
293. E. B. Escott (2 solutions), J. M. Gallagher, F. W. Gentleman, A. M. Harding, L. E. A. Ling, R. M. Mathews, C. E. Rogers, Nelson L. Roray, Elmer Schuyler, H. H. Seidell, F. Eugene Seymour, G. M. Weld, D. T. Wilson. (14)
294. T. M. Blakslee, A. M. Harding, G. I. Hopkins, L. E. A. Ling, R. M. Mathews, Nelson L. Roray, G. Sergent, Elmer Schuyler. (8)
295. A. M. Harding, G. I. Hopkins, R. M. Mathews, Kenneth Reynolds, Nelson L. Roray, Elmer Schuyler, E. E. Whitford. (7)
296. Nelson L. Roray, Elmer Schuyler. (2)

Solutions for 292 and 294 were received from a Chicago contributor who failed to give his name. (2)

Total number, 54.

PROBLEMS FOR SOLUTION.

Algebra.

308. *Proposed by John M. Gallagher, Boston, Mass.*

In "Dubbs' Arithmetic Problems" occurs the following: "If the cost had been 8% less, the gain would have been 10% more. What was the per cent of gain?"

The solution is given as follows:

"Make 8 the first term, 10 the second term and 100—8 the third term of a proportion. The fourth term is the selling price.

Problem: Discover the general principle involved in the above method of solution; or, prove algebraically that the above solution is sound.

309. *Proposed by E. B. Escott, Ann Arbor, Mich.*

Solve:

$$x^2 - yz = a \quad (1)$$
$$y^2 - xz = b \quad (2)$$
$$z^2 - xy = c \quad (3)$$

Geometry.

310. *Proposed by Benjamin E. Chiu, Shanghai, China.*

Divide a rectangle 7 inches long and 3 inches broad into three figures which can be joined together so as to form a square. (Ex. 28, p. 465, Phillips and Fisher's Elements of Geometry.)

311. *Proposed by W. T. Harlow, Portland, Ore.*

Three men undertake to saw a log which is 4 feet in diameter. How far into the log should each of the first two saw in order to equalize the work ?

312. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

In a given circle, inscribe a triangle, knowing the mid-points of the three minor arcs subtended by the three sides of the triangle. (From Ghersi.)

SCIENCE QUESTIONS.

By Franklin T. Jones.
University School, Cleveland, Ohio.

Readers of School Science *are invited to propose questions for solution—scientific or pedagogical—and to answer the questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

86. Why give a laboratory examination similar to that given by Harvard University?

What can an examiner find out by such an examination?

In what ways can the examination benefit (1) the pupil; (2) the teacher?

Answer serially numbered questions in the following lists:

Sheffield Scientific School Entrance Examinations, June, 1912.

Physics.

87. What should be the level of water in a stand pipe to maintain a pressure of 70 pounds to the square inch, assuming the density of water to be 62.5 lbs. per cu. ft.?

2. The boy, B, can run 900 feet per minute; the boy, A, who can run 1200 feet per minute gives B, 30 seconds start and sets chase. Where will he overtake B?

88. Suppose that heat is supplied at a uniform rate to a mass of ice at —20°C until it becomes steam at 120°C. Describe the resulting physical changes and give a rough estimate of the duration of each change compared to the time required to heat the freezing water to the boiling point. (Specific heat of ice 0.5; specific heat of steam 0.48.)

4. Describe the phenomenon of resonance as illustrated by a tuning fork held over the mouth of a tube. What relation is fulfilled when the tube resounds?

5. A needle is suspended at its centre of gravity; after being magnetized how will it behave differently? Compare its behavior at two points widely separated in latitude and longitude.

6. Describe electrostatic induction, magnetic induction, and electromagnetic induction.
7. Explain by a diagram the meaning of the critical angle at the boundary between water and glass.

Chemistry.

1. Write the formula of one oxide of each of the following elements: Sodium, calcium, carbon, phosphorus, sulphur, iron. Show by equations any reactions of these oxides (a) with water, (b) with each other.
2. Mention the raw materials and give the operations necessary for making nitric acid. Illustrate its acid properties by equations for its reactions on zinc hydroxide and on sodium carbonate. Illustrate its oxidizing property by equations for its reaction on sulphur dioxide.
3. Give the pressure and temperature laws for gases. A gas has a volume of 10 liters at 760 mm. What will be its volume at 780 mm if the temperature remains unchanged?
4. Write the formulas for twelve salts of which three shall contain phosphorus, three aluminum, three magnesium, three carbon.
5. Describe the phenomena observed when solutions of the following are mixed: (a) Silver nitrate and sodium chloride, (b) barium chloride and sulphuric acid, (c) hydrochloric acid and ammonium carbonate, (d) hydrogen sulphide and lead nitrate.

89. Find the volume in cubic centimeters of hydrochloric acid solution of 1.1 specific gravity, containing 20% of actual acid by weight, which will react with 10g of calcium carbonate.

7. Balance the following equation:

$$PbS+HNO_3=Pb(NO^3)_2+NO+S+H_2O.$$

90. What volume of oxygen would be required to burn 1000cc of carbon monoxide, and what would be the volume of the product, all the gases being at the same temperature and pressure?

(Atomic weights:—Ca=40, C=12, O=16, H=1, Cl=35.5.)

Solutions and Answers.

69. *From Cornell entrance examination in agriculture.*

How much nitrate of soda containing 15% N acid phosphate containing 16% phosphoric acid, and muriate of potash containing 50% potash, will be required to make the equivalent of a ton of 2:8:5 fertilizer?

Solution by Firman E. Bear, Dept. Agricultural Chemistry, Ohio State University.

222 lbs. nitrate soda 15% N = 18% NH_3.
1000 lbs. acid phosphate 16% P_2O_5.
200 lbs. muriate potash 50% K_2O.
578 lbs. filler.

———

2000 lbs. — 2 — 8 — 5.

70. *From a Cornell entrance examination in agriculture. A New York dairy farmer has a 100-acre farm of fairly good land:*

(*a*) What crops should be grown on it for his purposes?
(*b*) What acreage of each should be grown?
(*c*) What rotation should be followed?

Solution by W. L. Clevenger, Dept. of Dairying, Ohio State University.

I am assuming that 25 cows can be nicely kept and cared for on a dairy farm of this size. A few head of swine should also be kept. I would use 30 acres for buildings, garden, small orchards, fruit, and a

paddock for cattle and swine to graze in. The remainder should grow the following crops: As alfalfa will usually grow in New York I should attempt to raise 10 acres of it. I would grow 15 acres of silage corn which should average 10 tons per acre. I would also grow 15 acres of field corn and would also try 15 acres of clover and 15 acres of oats. Part of the clover or oats might be substituted by cow peas or soy beans, which will grow successfully in some parts of New York.

I would follow the five-year rotation as near as possible, following the clover with corn; oats or cow peas with silage. In case wheat can be successfully grown I would sow the silage ground into the wheat, and clover in the spring. With this sort of combination and a few concentrates a dairy farmer ought to be able to feed his animals as economically as it is possible to be done and make the most out of his 100 acres.

77. *Proposed by A. Bjorkland, Appleton, Wis.*

Explain how to get the total weight of a boat; what dimensions would you want, and how would you compute the weight from these?

Answer by J. H. Wells, Sales Manager, The Matthews Boat Co., Port Clinton, Ohio.

Answering yours regarding the manner of figuring weight of a boat will say, that the only way to figure the weight is to estimate the weight of every piece going into the construction, and by simple addition make the total.

We presume, however, that the person asking the question, wanted to know how to figure displacement. It is a more or less elaborate calculation if great accuracy is sought. There are a number of rules that one becomes familiar with by experience, among which certain variables must be estimated. For instance, on a motor boat, a quick rule for displacement is to multiply the W.L. length times the W.L. depth times the depth of rabbet below waterline times 64 (weight of 1 cu. ft. of salt water) times a variable, ranging between .35 and .42.

The second method is by use of the integrater and the summing up of the areas of the sections by Simpson's rules of integration, thus getting the volume and weight. The ordinary way is to use Simpson's 4-2-4 rule in getting the areas of each of the sections in which the boat is divided (usually ten), and by the same rule integrating each section of areas and finding the total displacement. You probably are familiar with these integration rules, and would say that you could use either Simpson's or Trapezoidal.

78. Mechanical advantage 5, efficiency 80%.

79. 13 cents per hour.

80. .5375 grams.

NEED OF A PHOSPHATE LAW.

The present uncertainty whether the phosphate rock of the public land should be entered under the lode law or under the placer law is conclusive evidence of the need of legislation. As a matter of fact neither of these laws is more applicable to the acquisition of beds of phosphate-bearing limestone than it would be to that of coal beds. The realization that the phosphate deposits are more extensive than was known or suspected when the Survey geologists began land classification work in Idaho and Wyoming does not lessen but rather increases the urgency for a leasing law which will provide for the utilization of this large supply of mineral fertilizer, so as to meet both present and future needs.—*United States Geological Survey.*

EASTERN ASSOCIATION OF PHYSICS TEACHERS.

The sixty-second meeting of this association was held at the Charlestown Navy Yard Saturday, June 1. The meeting was called to order by President Griswold, who at once called on Mr. Packard, chairman of the committee on new apparatus, for his report. Several new devices were shown. Mr. Bulfinch reported for the committee on magazine literature. Mr. Hadlock gave his report from the committee on current events in physics. Mr. Clarence M. Hall, then from the new book committee, read a review and criticism of Carhart and Chutes' new physics. New members were then elected. Commander S. V. Kittell, inspector of the Yard, then gave an interesting talk on the "Navy Yard." Commander E. J. Pollock followed with a talk on the battleship "Virginia." This was very interesting and was listened to with closest attention. The president, Mr. Griswold, followed with an entertaining and helpful talk upon some physics matter which it had been his privilege to observe and study. Luncheon was served in the hall outside of the armory. In the afternoon an inspection of the "Virginia" and the Yard was indulged in. Commander Pollock acted as host while the party was on board; a thorough inspection was made. This was followed by an inspection of the Yard conducted by Inspector Clark, visits were paid to the chain shop, rope shop, boat shop, dry dock, and to the old "Constitution."

Everyone present thoroughly enjoyed and appreciated this particular meeting.

PERSONALS.

Dr. George E. Hale, director of the Solar Observatory of the Carnegie Institution, has had conferred upon him the doctorate of laws by the University of California.

Dr. Charles A. Shull of the Transylvania University, Lexington, Ky., who has been for a number of years an associate editor of this journal, has accepted the position as Professor of Plant Physiology at the University of Kansas. He enters upon his new duties this fall.

Professor Ansel F. Hemenway of the University of Chicago has been appointed to the professorship of biology and geology in Transylvania University, Lexington, Ky.

Dr. Alexander Meiklejohn, professor of philosophy and dean of the faculty of Brown University, has been elected president of Amherst College.

Professor B. M. Duggar of Cornell University has been elected to fill the professorship of plant physiology and applied botany in Washington University, vacated by Dr. George T. Moore, in accepting the directorship of the Missouri Botanical Garden.

Dr. William Conger Morgan, assistant professor of chemistry at the University of California, and associate editor in chemistry of this Journal, has been appointed professor of chemistry at Reed College, Portland, Ore.

At Princeton University, William F. Magie, Henry professor of physics, has been elected dean of the faculty to succeed Professor H. B. Fine.

Professor H. P. Baker of the Pennsylvania State College has accepted a position at Syracuse University as dean of the State College of Forestry, established in 1911 by the New York legislature with an initial appropriation of $55,000.

Mr. W. P. Morgan of the Englewood, Chicago, High School has been elected to the presidency of the normal school at Macomb, Ill.

Mr. Mark A. Carleton, for the past eighteen years in charge of grain investigations in the Bureau of Plant Industry, and well known as the introducer and propagator of Durum wheat and the Swedish select oat, has resigned his present position to take charge of the work of the Pennsylvania Chestnut Tree Blight Commission.

Mr. C. E. Craig, instructor in agronomy in Purdue University, has accepted the position of agronomist in the Polytechnic School at Porto Alegre, Brazil.

Professor Richard S. Curtis of the University of Illinois has resigned to become professor of organic chemistry at the Throop Polytechnic Institute, Pasadena, Cal.

Mr. L. L. Burgess, associate in chemistry, has accepted the position of professor of analytical chemistry at the University of Saskatchewan, Canada.

Professor Henry G. Gale of the University of Chicago becomes managing editor of the *Astrophysical Journal*, which position has been held by Professor Edwin B. Frost for the last twenty years.

Mr. W. H. Zeigel has been appointed Head of the Department of Mathematics in the first district Normal School at Kirksville, Mo. He enters upon his new duties this fall.

President McKenney of the Milwaukee Normal School has been made President of the Michigan State Normal College at Ypsilanti.

PROPOSED AMENDMENTS TO THE CONSTITUTION OF THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

The committee on amendments to the constitution of the Central Association of Science and Mathematics Teachers, appointed at the last annual meeting, recommends the following amendments, to be acted upon at the meeting of the Association November 29, 30, 1912. Articles VI and VII to be changed to read as follows:

ARTICLE VI. OFFICERS.

Section 1. The officers of the Association shall be a president, a vice-president, a secretary, an assistant secretary, a treasurer, and an assistant treasurer.

Section 2. The officers of each section shall be a chairman, a vice-chairman, and a secretary.

Section 3. The duties of the officers shall be those usually devolving upon such officers as those named.

Section 4. The officers of the Association and of the sections shall be elected by ballot at the annual meeting. A majority of the votes cast shall be required for election. The president, vice-president, assistant secretary, and assistant treasurer each shall be elected for a term of one year. The secretary shall be elected for a term of three years. The treasurer shall be elected in 1912 for a term of one year; thereafter the treasurer shall be elected for a term of three years. The treasurer shall furnish bond for $1,000, the same to be approved by the executive committee, the premium upon this bond to be paid by the association.

Section 5. Nominations for officers of the Association shall be made by a nominating committee of three members appointed by the president. Nominations for officers of each section shall be made by a nominating committee of three members appointed by the chairman of that section.

ARTICLE VII. EXECUTIVE COMMITTEE.

Section 1. The officers of the Association, the past presidents of the Association, and the chairmen of the sections shall constitute an executive committee. Its duties shall be to prepare programs and to arrange for meetings of the Association; to decide what portions of the proceedings shall be published by the Association; to pass upon applications for membership in the Association; and to elect new members; to fill all vacancies in the offices of the Association and the sections; and to transact all business of the Association not otherwise provided for.

Section 2. The officers of each section shall constitute a section executive committee. The duties of this committee shall include the preparation of programs.

JAMES F. MILLIS,
JAMES H. SMITH,
C. E. SPICER,
Committee.

GOOD TRAINING.

"When I was a growing lad, and came upon many words in my reading that I did not understand, my mother, instead of giving me the definition when I applied to her, uniformly sent me to the dictionary to learn it, and in this way I gradually learned many things besides the meaning of the individual words in question—among other things, how to use a dictionary, and the great pleasure and advantage there might be in the use of the dictionary. Afterwards, when I went to the village school, my chief diversion, after lessons were learned and before they were recited, was in turning over the pages of the 'Unabridged' of those days. Now the most modern Unabridged—the NEW INTERNATIONAL—(G. & C. Merriam Co., Springfield, Mass.) gives me a pleasure of the same sort. So far as my knowledge extends, it is at present the best of the one-volume dictionaries, and quite sufficient for all ordinary uses. Even those who possess the splendid dictionaries in the several volumes will yet find it a great convenience to have this, which is so compact, so full, and so trustworthy as to leave in most cases, little to be desired."

ALBERT S. COOK, PH.D., LL.D.,
Professor of the English Language and Literature, Yale University.

ARTICLES IN CURRENT PERIODICALS.

Education for May: "Moral Standards in the Schools," Alfred E. Stearns; "Moral Standards in College," Flavel S. Luther; "The Growth of the Moral Ideal," Arthur Deerin Call; "Marks and the Marking System as an Incentive," Stephen S. Colvin; "The Ideal as an Incentive," John B. Diman.

Journal of Educational Psychology for June: "Methods of Research in Education," Edmund C. Sanford; "Shall We Teach Spelling by Rule?" W. A. Cook; "Retardation in Fifty-five Western Towns," Freeman E. Lurton; "An Achievement Capacity Test," Guy G. Fernald.

Journal of Geography for May: "Geographic Influences in the Development of Texas," Frederic William Simonds; "Geography of the United States in the High School," Harley P. Chandler; "Laboratory Work in Physiography in the Chicago High Schools," Harry M. Clem; "The Status of Geography in Minnesota High Schools," C. E. Huff. For June: "Geography in American Universities," Huldah L. Winsted; "The Precious Metals as a Factor in the Development of the United States," George D.

Hubbard; "The Development of Physical Geography in American Text-books," Beulah A. Mullinger; "Notes on Canada," Edward Van Dyke Robinson; "The Use of Artificial Light in a Sub-Arctic Region," Philip S. Smith.

L'Enséignément Mathématique for May: "Les fractions continues dans la théorie ëlëmentaire des nombres," A. Aubry; "Courbes transcendantes et interscendantes," E. Turrière; "Nouvelle note sur les fonctions de mesure," G. Combebiac.

Mathematical Gazette for May: "Four Fours. Some Arithmetical Puzzles," W. W. Rouse Ball; "The Theory of Order, as Defined by Boundaries" (concluded), E. T. Dixon; "Suggested Notation for Ratios and Cross-Ratios," A. Lodge.

Nature-Study Review for May: "A Robin's Nest," C. W. Finley; "The School-Home Garden," E. C. Bishop; "Mushrooms," C. H. Kauffman; "The Insect Life of Pond and Stream," Paul S. Welch; "Some Ideas on Teaching a Bird Course," R. M. Strong; "The Study of Birds with the Camera," Robert W. Hegner.

Photo-Era for June: "Color-Photography," Henry Leffman; "Sizes and Shapes of Plates and Films," Phil M. Riley; "Art and the Exact Sciences," Right Hon. Lord Redesdale; "Photography a Pursuit for the Busy Man," H. C.; "Straight Photography," first paper, David J. Cook. For August: "Aeroplane-Photography," Charles G. Grey; "On Print-Criticism," Virginia F. Clutton; "The Story of the First Kodak," Wilfred A. French; "Pictorial Surgery," William Howe Downes; Persuading a Business Man," Phil M. Riley; "Straight Photography," third paper, David J. Cook; "Bromoil—The Printing Process of the Future," Dr. Emil Mayer.

Physical Review for July: "On the Vibration of a Lecher System using a Lecher Oscillator, II," F. C. Blake and Charles Sheard; "Nutation in Practical Applications of Gyro-action," Burt L. Newkirk; "Circular Dichroism and Rotatory Dispersion of Certain Salt Solutions," L. B. Olmstead; "The Definition of an Ideal Gas," E. F. Farnau; "A Relation Between the Magnetic and Elastic Properties of a Series of Unhardened Iron-Carbon Alloys," C. W. Waggoner; "The Crystallization of Carbon-Dioxide, Nitrous Oxide and Ammonia," H. E. Behnken.

Popular Astronomy for June-July: "The Turret Telescope," with plate XIII, S. A. Mitchell; "The Form of the Earth," concluded, William Thayer Jordan; "The Distances of the Stars," Heber D. Curtis; "An Inexpensive but Valuable Device for the Amateur in Star Observation," Tilton C. H. Bouton; "Astral Disks and Colored Stars," Dr. Edward Gray; "The Hyades Group of Stars," H. C. Wilson; "Laplace on Atmospheres of Celestial Objects," translated by Miss Florence L. Baldwin; "The Occultation of Antares, June 26, 1912," Wm. F. Rigge; "The Eclipse of April 17 as Visible in France," B. G. Harrison. For August-September: "The Study of Solar Prominences," with plates XIV-XVI, Frederick Slocum; "An Account of the Founding of the Central Observatory of Poulkova, Russia," Frances Montgomery Cowan; "On Some Educational Stellar Photography," with plates XVII-XXIII, Charles Burckhalter; "Magnitude Estimates of Nova Geminorum," No. 2, Joel Stebbins; "The Distance of the Stars," (concluded) Heber D. Curtis; "The Riddles of Mizar and Beta Aurigæ," William H. Knight; "Observations of Nova (2) Geminorum," Frederick C. Leonard; "Note on the Hypothesis of M. Birkeland Relative to the Nature of the Rings of Saturn," (Translation), P. Stroobant.

Popular Science Monthly for June: "Tropical Sunlight," The Late Paul C. Freer; "The National Parks, from the Scientific and Educational Side," Laurence F. Schmeckebier; "Research in Medicine," Richard M. Pearce; "Age, Death, and Conjugation in the Light of Work on the Lower Organisms," Herbert S. Jennings; "Conservation Ideals in the Improvement of Plants," H. J. Webber; "A Philosophy of Geography," Walter Edward McCourt; "Chinese Mathematics," David Eugene Smith; "The Practical Basis for Republican Institutions for China," Gustavus Ohlinger;

"A Program of Radical Democracy," J. McKeen Cattell. For July: "Research in Medicine," Richard M. Pearce; "Trinidad and Bermudez Asphalts and their Use in Highway Construction," Clifford Richardson; "The Role of the House Fly and Certain Other Insects in the Spread of Human Diseases." W. E. Britton; "Holes in the Air," W. J. Humphreys; "The Physiological Basis of Esthetics," Henry Sewall; "Are the Jews a 'Pure Race'?" Abram Lipsky; "Is a Scientific Explanation of Life Possible?" Otto C. Glaser; "Some Features of the Root Systems of Desert Plants," W. A. Cannon. For August: "Gauss and His American Descendants," Florian Cajori; "Research in Medicine," Richard M. Pearce; Modern Thought," Edward F. Williams; "Cold Storage Problems," P. G. Heinemann; "The World's Most Important Conservation Problem," Stewart Paton; "Trinidad and Bermudez Asphalts and their Use in Highway Construction," Clifford Richardson; "An Economic Interpretation of Present Politics," C. C. Arbuthnot; "Helps to Studying," Joseph W. Richards; "Bees which only Visit One Species of Flowers," John H. Lovell.

School Review for June: "Report of the Twenty-fourth Educational Conference of the Academies and High Schools in Relations with the University of Chicago," Nathaniel Butler; "Legislation for the Last Three Years on Vocational Education," Rupert R. Simpkins.

School World for June: "Mathematical Essays," Charles Davison; "An Experiment in Applied Education," A. H. Angus; "The Use of Practical Exercises in the Teaching of Geography," by fifteen different authors. *Very valuable.* For July: "The Value of Geography and History in Elementary Education," Rachel R. Reid; "The Teaching of Mathematics in the United Kingdom," J. B. Dale; "The Teaching of Elementary Geography."

Unterrichtsblätter für Mathematik und Naturwissenschaften, Nr. 3: "Das Sellenleben der Ameisen," P. E. Wasmann; "Eine Konstruktion aus imaginären Punkten," Dr. Clemens Thaer.

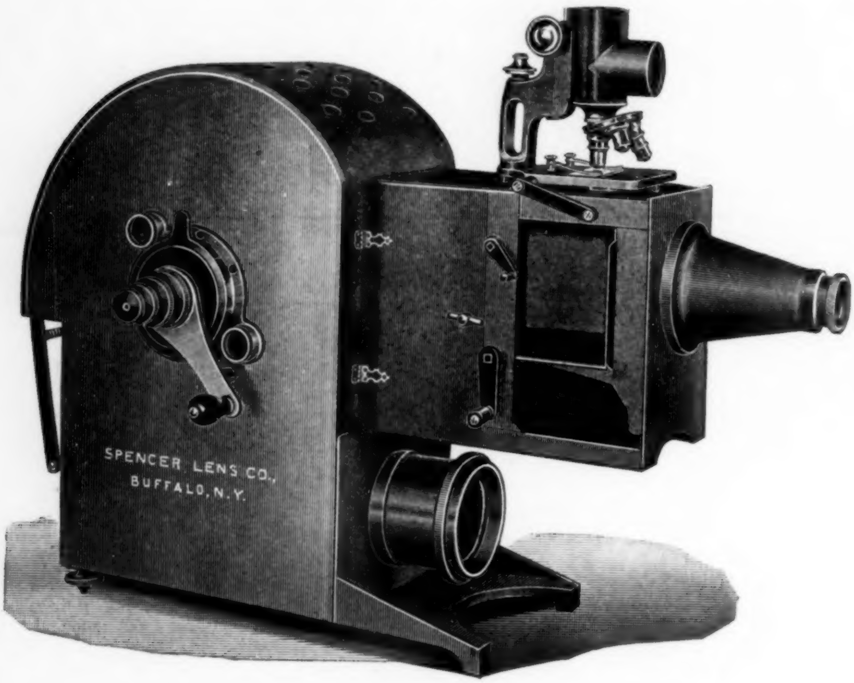
Zeitschrift für den Physikalischen und Chemischen Unterricht for July: "Einfache Versuche über Linsenfehler und ihre Beseitigung," W. Volkman; "Versuche mit überschmolzenem Natriumazetat," H. Rebenstorff; "Zur Demonstration der Gezetze des freien Falls," W. Elsässer; "Zwei Lochsirenen." A. Kleine Mitteilungen: "Ein einfacher Geschwindigkeitsmesser," Fr. Heselhaus; "Apparat zur Demonstration des Druckes gesättigter Dämpfe," F. Meiszner; "Uber die Bildung stehender Wellen bei Explosionen," J. Stepanek; "Mischung natürlicher Spektralfarben," H. Reuter; "Zwei elektromagnetische Versuche," E. Pfeiffer; "Versuche über den Nachweis des Jouleschen Gesetzes mit dem Looserchen Thermoskop," A. Krause; "Explosionsmöglichkeiten bei Versuchen mit Wasserstoff," H. Rebenstorff.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht for April: "Beiträge zur Didaktik des mathematischen Unterrichts in den Gymnasien," Schulrat Dr. Al. Lanner; "Für oder wider die Dreieckskonstruktionen," Prof. Ernst Meyer; "Die Diagonaltangenten der Ellipse," Prof. Rudolph Hein; "Ein Grenzfall des Ptolemäischen Lehrsatzes," Dr. H. Wieleitner; "Lehrsätze über die Fusspunkte der Höhen der von vier Punkten gebildeten Dreiecke," Prof. K. M. Hippach; "Schriften des Deutschen Ausschusses für den mathematischen und naturwissenschaftlichen Unterricht," W. Lietzman; "Zur Geometrographie," edited by K. Hagge.

DELINEASCOPES.

Delineascope is a new word—a name coined by the Spencer Lens Company, Buffalo, N. Y., to designate a new series of Projection outfits recently placed on the market. Their new catalogue describing the same recently received, and which may be had for the asking, illustrates and describes in detail these very unique outfits.

Realizing that the stumbling block in projection work, due to a lack



of proper illumination, has been *not* the projection of lantern slides or even micro objects but rather the projection of opaque objects, post cards, reading matter, etc., this Company has designed their Delineascopes with these facts uppermost in mind. By original and unique methods of handling the light as well as means for its conservation, coupled with the fact that the *mechanism for opaque projection is not merely an accessory, not an extra attachment, but an integral part of itself,* they have been able to attain results which are extremely satisfactory and this at a greater distance even, from the screen, than heretofore considered practicable.

A glance at its construction reveals the fact that it is different in design from anything in projection heretofore built. Its construction is certainly unique. A number of original features have been incorporated. All operations are on one side. Simple, quick and handy provisions are provided for changing from one kind of projection to another. The micro attachment can be used in a perpendicular or horizontal position and can be changed from one position to the other in a moment's time. The most striking innovation is the *Spencer Transposer* for handling lantern slides. By it the slides are not only interchanged in a simple and suitable way, but the pictures on the screen are *transposed* in a way as pleasing to the eye as the old "dissolving effect" heretofore accomplished only by the use of two outfits, one above the other. This effect is attained with a single delineascope. The effect is more like that produced by the moving picture machine, the new picture being on the screen before the retina takes cognizance of the change.

The control and conservation of light is so arranged that opaque objects —objects of considerable thickness—objects of rotundity are illuminated

not only from the rear but from all sides, thus avoiding the pronounced shadows on three sides of such objects, and especially in front as has usually been observed when such work has been attempted. If this has been successfully accomplished, as the makers claim these Delineascopes certainly offer advantages worthy the consideration of those contemplating the purchase of projection outfits.

BOOK REVIEWS.

Applied Physics, by V. D. Hawkins, Technical High School, Cleveland. Pages ix+199. 11x20 cm. Cloth, 1912. Longmans, Green & Co., New York.

A splendid book, one in which the author has kept aloof from the erg, dyne, and other terms which do not particularly help the "average" high school pupil, and coupled the book and student to the common everyday phenomena of life. It is a book in which one will become interested because he is brought in touch, quickly, with those fundamental principles of physics which have already, to a great extent, arrested his attention. The author does not claim to have covered all the physics ground in this text, he has left to the live, well-informed instructor that interesting and helpful phase of the subject, the illustrative experiment.

The work is divided into nine chapters with headings as follows: mechanics; dynamics; mechanics of fluids; strength of molecules; sound; light; heat; heat engines and transmissions of heat and magnetism and electricity.

There are one hundred sixty-nine drawings and half-tones, all being selected to illustrate clearly the principles in physics under discussion. Many practical problems are given, in the solution of which the pupil will be able to lay hold of the subject-matter understandingly.

C. H. S.

The Francis W. Parker School Year Book, Vol. I, by the Faculty of the Francis W. Parker School, Chicago. Pages 140. Price 35 cents. Press of the Francis W. Parker School, 330 Webster Avenue, Chicago, 1912.

The faculty of the Francis W. Parker School, Chicago, has undertaken to publish annually a volume entitled the *Francis W. Parker School Year Book*, consisting of a series of concrete, illustrated reports of work actually done in the school.

This school is in the nature of an educational laboratory, or an experiment station in education. Being unhampered by the traditions that beset the average school, and free to experiment in any way with the content of the course of study and methods of organization and teaching, the school is endeavoring to carry out certain modern fundamental principles and aims in education—principles and aims advanced especially by Colonel Francis W. Parker, one of the pioneers in the modern educational movements in this country.

The school proposes to share, with the general educational public, the benefits of its experimentation, through the Year Book. Each volume will be devoted to some one phase of education as actually worked out in the school.

Volume I is devoted to the *social motive in school work*, and consists of a number of reports dealing with phases of handwork, music, dramatics, etc., in which the *social motive* predominates. The reports are plentifully illustrated—thirty-six illustrations in all—and show in a concrete way how the projects or activities described are made use of in

the class room. The experiences of the school are thus suggested in dealing with the great educational problems of motivation, correlation, etc., of the present day.

The volume should be of immense practical value to every teacher in the country.

Elements of Hydrostatics, with numerous examples, by George W. Parker, Trinity College, Dublin. viii+150 pages. 13x19 cm. Cloth, 1912. 90 cents net. Longmans, Green & Co., New York.

This book follows the plan of the author's Elements of Mechanics. It is an elementary work written for those students whose knowledge of mathematics is limited. A knowledge of elementary geometry and algebra and a few of the more fundamental principles of mechanics is all the mathematics one needs for an understanding of the book. There are eight chapters. It is written in a clear and understandable language. Covers but very little more ground in this subject than the later American texts in secondary school physics. There are forty-eight drawings, many of which should have been made by a drawing master. It abounds with numerous well-selected examples illustrating the principles studied.

C. H. S.

Report of the Illinois State Museum of Natural History, for 1909-10, by G. R. Cook. Curator, 557 pages. 16x22 cm. Cloth. Illinois State Journal Company, Springfield.

A commendable report of this institution: It consists of three divisions. Part I, General Report. Part II, Dictionary Catalogue of Museum's Library. Part III, Catalogue of Fossils on Exhibition.

Part I gives a short history of the origin and growth of the museum together with an account of the work being done. It also contains a strong plea for the erection, by the state, or a suitable building to house its valuable collection and at the same time making it more accessible to the public. A long list of letters from prominent scientists and educators of the state, favoring the project, is given. This building must come. People interested should agitate the question, work for the passage of a bill by the legislature authorizing its construction.

Part II is valuable in that is consists of a catalogue of valuable books and articles on science and kindred matters, possessed by the museum. Part III is devoted to a list of fossils on exhibition which are alphabetically arranged and tells the locality from which the specimen came.

It will be a valuable book of reference to anyone interested in science.

C. H. S.

Chemistry in High Schools. Bulletin of the University of Texas, by E. P. Schoch. Pages viii+117. 15x23 cm. Paper, July, 1912. Price, free. University of Texas Press, Austin, Tex.

A book which is worth while for every teacher of chemistry to own. The reviewer has nothing but words of commendation to express concerning it. Write and get a copy, it is free for the asking. All teachers probably, will not agree with every statement made by this splendid teacher and chemistry enthusiast, the author. The bulletin is made to use on earth. Any teacher or school about to establish a course in chemistry should possess a copy as it tells what to do and how to do it. Teachers in chemistry courses already in operation, should have a copy as it tells what a teacher, abreast of the times, is doing. The work is divided into four parts. Part I. Equipment, is filled with just that kind of information that a teacher of chemistry must know about. Part II. Plan and Conduct of the Course. Here are discussed the *why* and *how* and the *essentials* of a practical up-to-date course in chemistry.

Part III. Outline of an Introduction to the First Principles. Here the teacher will find an outline of the fundamentals which should be taught. Part IV is a discussion of alternating current rectifiers.

Every reader of this description of the bulletin should send for a copy. C. H. S.

Superintendents and Principals Association of Northern Illinois. Seventh Year Book. 39 pages. 17x24 cm. Paper, 1912. The University of Chicago Press.

Reports of meetings of this and other associations have heretofore consisted very largely of discussions of fundamental principles. There has always been a demand for something tangible, something which could at once be put into practical operation. This report confines itself entirely to the consideration in a practical way to three phases of elementary school work. "Third Grade History Work in Francis W. Parker School" is discussed in an eminent, practical and suggestive manner, by Pearl B. Conley. Her discussion is full of helpful hints. The second subject, "Heat as a Topic for the Experimental Science Work of the Eighth Grade," is handled by that prince of teachers, Otis W. Caldwell, of the University of Chicago. A splendid outline for work to be done with simple apparatus is given. "Corn," the third topic, is handled by Charles A. McMurray of the Northern Illinois Normal School, in a manner which at once appeals to teacher. The outline is such that it can be carried out in any school with effectiveness.

C. H. S.

The Teaching of Physics, by C. Riborg Mann, University of Chicago. Pages xxv+304. 13x20 cm. Cloth, 1912. $1.25 net. The Macmillan Company, New York.

A book for which teachers of physics have long been waiting. It is the result of the collected data and contributions of the author's long and intimate connection with the New Movement among Physics Teachers. It is a live book in every respect and demonstrates that the cultural side of education can be developed equally well from the study of physics as from the study of Greek literature or any other of the Humanities if properly handled, and at the same time the practical or vocational phase of the subject can be emphasized to the fullest extent. It will exert a tremendous influence in helping to destroy this mythical partition which has existed aparently impregnable for decades, between the so-called cultural subjects and those of a "daily bread" character.

The book is divided into three parts the first of which traces "The Development of the Present Situation," discussed in four chapters under the following heads: Natural Philosophy, Prescribed Physics and Textbooks, Books New and Old. Part two deals with "Physics and Democratic Education" likewise in four chapters with titles like this: The Pedigrees of Physics, The Methods of Physics, The Biography of Physics, and The Discipline of Physics. No one can truthfully take exceptions to the treatment of the phases of the work in these two divisions. There may be a chance for some disagreement with the third part. Yet the matter is treated in an eminently logical and systematic manner, showing careful thought and study. Very few readers of the book will at present, at least, be able to improve upon the methods and suggestions given under "Hints at Practical Applications" with chapters on: The Concrete Problem, The Organization of the Course, The Laboratory and Testing Results.

The chapters in parts II and III are supplied with a list of references to kindred subjects. none of which, however, have been published more

than twelve years. A bibliography of nine pages is given at the end which contains list of articles bearing upon this work which have appeared in the more important educational Journals, during the past decade. It is a work which every physics teacher should read, is interesting and full of information and ideas, and deserves a wide circulation which it doubtless will have. C. H. S.

Outlines of Applied Optics, by P. S. Nutting, Bureau of Standards, Washington, D. C. ix+236. 73 illustrations. 14x21 cm. Cloth, 1912. $2.00 net. P. Blakiston Son & Co., Philadelphia.

This book deals with optical instruments and measurements from the standpoint of sensibility and precision. The introduction discusses some of the fundamental principles of optics, while the first three chapters treat of the formation of images and the instruments used in producing them; the remaining nine chapters describe special instruments for studying light and determining optically the properties of certain materials. The book is not written so much for the benefit of the student and investigator as for the actual worker in applied optics. The real worker in optics has had his university training and understands that in photography, colorimetry, illuminating engineering, optical engineering-lens design, etc., his knowledge of the theory of light must now be applied in a practical way to better conserve our sources of light energy through the use of more perfect optical instruments. One of the most neglected fields of investigation is that of applied optics. This book will greatly aid anyone who may select this field for study. Each chapter closes with a list of references to articles on kindred subjects. All students and workers in optics and optical instruments should provide themselves with a copy of this book. C. H. S.

Earth's Features and Their Meaning, by William Herbert Hobbs, University of Michigan. Pages xxxiv+506. 15x22 cm. Cloth, 1912. $3.00 net. The Macmillan Company, New York.

The name of the author of this volume is a sufficient guarantee of its high worth and character. It has been written both for the student and general reader. It consists, very largely in an expanded form, of a series of illustrated lectures which have been given for a number of years, each semester, at the University of Michigan. As one studies the volume, he is impressed with the fact that the predominant characteristics of it are a general description of the Earth's features and its geological processes which have brought them about. The author has not even attempted to cover the entire field of geology, but has confined himself to those geological processes and phases which are best illustrated by examples in North America and Europe. The subject matter is presented in such an interesting and intelligent manner that the general reader and student will receive from its study such an understanding of the subject that he will be able, in his travels, to recognize many of the earth's features about which he has read. The landscapes which are represented are very largely those which are along the routes of travel. Much stress has been placed on the dependence of the chief geological processes, of a region, upon the general climatic conditions there existing.

The subject-matter is treated in thirty-one chapters and five appendices. There are twenty-four full-page half-tone plates printed on extra calendered paper. Scattered throughout the book are 493 illustrations bearing directly upon the matter under discussion. Reading references to many journals and bulletins are given. They are referred to by abbreviations which are fully explained in a two-page explanatory list. A splendid list

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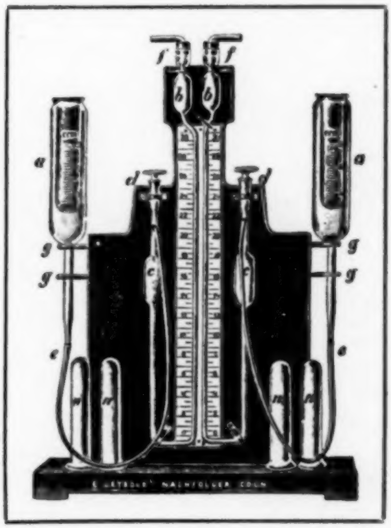

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of reference books and papers is appended at the end of each chapter. Principal paragraphs all begin with bold face type. A complete index of sixteen pages is given at the end.

This is a book which should be possessed by every teacher of earth science and geology, whether in secondary school or college. It deserves and doubtless will have a large circulation. C. H. S.

General Science, by Bertha M. Clark, William Penn High School for Girls, Philadelphia. 363 pages. 13x19 cm. Cloth, 1912. American Book Company, New York.

This is a splendid book which has been written for the purpose of giving to boys and girls, going out into life, a knowledge of scientific and economic principles about which they should all know. It has not been compiled for the benefit of the chosen few but for the many. Much stress is placed upon those principles and activities with which one comes in daily contact. It tells the young person how to best conserve his energies and resources, how to use them to the best advantage to himself and society in general.

A high school pupil of the first year and of average ability will have no difficulty in understanding and becoming interested in this book. It is written in a style and manner which at once appeals to the secondary school person.

It will make profitable reading for the mature man and woman. The author has endeavored to impart not information so much, as to stimulate a desire in the growing mind for something which is worth while. The science teacher will find nothing new in the subject-matter, but will find that the order and manner of presentation is different from that given in any other book of its kind.

There are thirty-five chapters covering very largely the subjects treated in physics. Chapters I-VII and XX-XXVI are devoted mainly to the chemical side of science. The leading paragraphs all begin with "bold face type." There are 241 illustrations and drawings which help greatly in the understanding of the text. It is written in a clear and forcible manner. Mechanically the book is well made and will stand hard usage. It is a work worthy of and doubtless will have a large sale.

C. H. S.

Medical Education in Europe, by Abraham Flexner. Pages xx+357. 18.5x25.5 cm. Paper, 1912. The Carnegie Foundations for the Advancement of Teaching.

This splendid report is an outgrowth of the Carnegie Foundation's report of medical education in the United States and Canada which appeared in June, 1910. This later volume follows very largely, the plans of the first. An analytical and comprehensive study of the situation in Europe has been made. It will assist in many directions, in causing the authorities of this country to enact such requirements as will put our medical schools on such a plane as will cause them to be on a par, at least, with the high humanitariam motives for which they should exist.

According to President Henry S. Pritchett, three fourths of the medical schools in America would be driven out of existence if the lowest terms, upon which such schools exist abroad, were applied in this country. The report after tracing briefly the historical development of the modern medical school in Europe, first discusses the distribution of physicians, showing that it is not necessary to make cheap and poor physicians in order that the country have physicians enough. The author finds medical education in Germany still leading the world, largely from the fact that they recognize what qualifications a good physician should possess,

how he should get them and under what control they should be managed. An important part of the report deals with examinations, comparing the methods of the Continent with those of the United States. It states that medical sects, as such, have no standing in Europe. It is the well-qualified physician who counts. People interested in the higher standard of medical education in this country should read and study the report.

C. H. S.

Lessons in Physics. A Manual for Laboratory and Class Work, by Herbert Brownell, Teachers' College, University of Nebraska. 132 pages. 15x22 cm. Cloth, 1912. 50 cents. The Torch Press, Cedar Rapids, Ia.

This is a revised edition of the author's manual and is greatly amplified and enlarged. It is divided into two parts. It is for use primarily in elementary physics. There are nearly three hundred qualitative experiments and over forty of a quantitative character. There are over two hundred questions inserted at the proper place in the body of the book. The apparatus used is simple and not expensive. Part II is a detailed outline of a year's work in physics. It is written in a clear and understandable way. The pupil will readily grasp the directions. Especial emphasis is put upon the method of teaching as an art for general culture.

The book lacks a table of contents and index, which would have added greatly to its worth. No drawings are given, the insertions of these at the proper place would have enhanced the value of the book. In every case where the abbreviations Inf. and Obs. are used it would have been better to have printed in full.

C. H. S.

Who's Who in Science, edited by H. H. Stephenson, Chemist Royal Doulton Potteries, Lambeth, England. Pages xvi+323. 15x23 cm. Cloth, 1912. $2.00 net. The Macmillan Company, New York.

A book which has made a heroic attempt to tell "who's who" in science of men in all civilized countries. The author has done his work well in so far as it has been possible for him to go. Many names of prominent scientists do not appear, largely from the unwillingness of the person to comply with the request for information concerning himself. Banish this false modesty, the world has a right to know you and what you are doing. What a charming impression is made on one's mind, when hunting for information, where it should be found, to find that which you are after. Help the author of this work by transmitting to him a short account of yourself.

"Those branches of knowledge which lie on the border line between Science and the Humanities have not been included." Some of these are Economics, Education, Pyschology, Sociology, etc. Those represented are as follows: Agriculture and Forestry, Anatomy, Anthropolgy, Astronomy and Meteorology, Botany, Chemistry, Engineering, Geology and Mineralogy, Mathematics, Mechanics, Pathology, and Pharmacology, Physiology, Zoölogy. There are, however, many names who have become leaders in the subjective sciences who at the same time have made brilliant success in the objective. In the biographical phase of the work more stress is put upon real work and worth than upon that side of science represented often in Ph.D. thesises, hence but few degrees are given, membership in recognized societies being given instead. All names, where possible, have been translated into their English equivalent. The names of Journals are given in the language in which they are printed. To save time, labor, and space many abbreviations are used. A two-paged key to these is given at the beginning. Names of scientists who died in 1911 are printed. A valuable feature of the book is a list of 146 of the great universities of the world, together with the location, date of foundation, president or principal, registrar, and the name of the

head professor of the sciences mentioned above. Each of the 5,000 (about) names is printed in bold face type followed in most cases with this information: position, positions held, where and when born, where educated, societies member of, books and articles written. There is a valuable classified index appended which gives the science in which the person is most interested and the country to which he belongs. It is a valuable book of reference. C. H. S.

Elements of Plane Trigonometry and Tables, by Daniel A. Murray, Ph.D., Professor of Applied Mathematics in McGill University. Pages ix+136+95. 14x21 cm. Price, $1.00. Longmans, Green & Co., New York.

It would seem as if students could readily grasp the clear-cut definitions and lucid explanations given in this book. The graphical method of solving triangles is given early, and its importance as a rough check is shown. The necessity of checking results is emphasized, but there is little incentive for students to check their results when the answers are printed in the text-book. Good graphs of the functions are printed, and there are some graphical problems. Some use is made of the line definitions of the functions. An excellent cardboard protractor is furnished with the book. The large type and well-spaced pages present an attractive appearance. H. E. C.

The Outlines of Educational Psychology, by William Henry Pyle, University of Missouri. Pages x+254. 14x20 cm. Cloth, 1912. $1.25 net. Warwick and York, Baltimore.

This book without any doubt is a high-class general text-book on educational psychology. The best text-books are written from one's experience as a teacher in the class room. This is a compilation of ideas thus gathered, and they are arranged in such a charming manner as to cause the book to be at the same time interesting to study and read to both pupil and teacher. Those facts and precepts have been selected for discussion which have direct bearing upon the art of teaching.

There are fifteen chapters. An idea of the general subjects discussed may be had from the headings which are as follows: Introduction; Body and Mind; Heredity; Instincts; The Individualistic Instincts; The Social Instincts; the Environmental Instincts; The Adaptive Instincts—Play; The Adaptive Instincts—Imitation; Habit, Habit and Education; Habit and Moral Training; Memory, Attention; Fatigue. The book abounds with good suggestions. It lambasts those high school abominations, the fraternity and sorority. It is not only a book for teachers, but it is one with which the parents of young children should become familiar. Statements like the one here quoted give one a cue to its high worth: "The boy who must hurry home from school to use the bucksaw, shovel, ax, or hoe, and who spends the evening around the family fireside reading and talking with his parents and brothers and sisters, is receiving a much better training for citizenship and manhood than the city boy who belongs to a fraternity and spends much of his time outside of the school and family in the **smut house, smoke house,* or *pool room.* A boy's best club should be the family circle and his best chum should be his father."

Each chapter closes with a list of English reference books bearing upon the matter under discussion and also a splendid list of questions is appended which have come, very largely, from the author's pupils.

Mechanically the book is made to stand hard usage. The type is large and clear. The principal paragraph begins with heavy bold-face type. It deserves a large sale. C. H. S.

*"The words in italics are the reviewes's."

Free Will and Human Responsibility, by Herman H. Horne, New York University. Pages xvi+197. 14x20 cm. Cloth, 1912. $1.50 net. The Macmillan Company, New York.

This work is largely a development of the author's class work while at Dartmouth College. It is a most interesting discussion of the question at issue. The best conception of the book is obtained by mentioning the titles of the eight chapters which are as follows: Analogous Issues, Historical Sketch of the Issues; The Issue, with prelininary remarks; The (Arguments for Determinism; Rebuttal of these Arguments for Determinism; the Arguments for Free Will; Pragmatism and Freedom; The Difference it Makes.

Titles to the main paragraphs, in each chapter, are printed in the margin. Many references to similar discussions are given in the body of the work. A bibliography of nearly one hundred works on philosophy is printed. Uncalendered paper is used, the type being large and clear, making the book one easy to read.

C. H. S.

Elementary Plant Biology, by James Edward Peabody and Arthur Ellsworth Hunt. 207 pages. 14x20 cm. 1912. $.75 net. The Macmillan Company, New York.

This book, according to the authors, is intended as a text and laboratory manual to meet the needs of fourteen-year-old boys and girls. The scope of the book is quite fully outlined in the preface which is here quoted freely.

With the three classes of activities—nutritive functions, reproductive functions, and the relation of plants to man clearly in mind the authors seek to unify the study of plant, animal, and human biology by choice of topics for study both in and out of class, and by the manner of presentation. Function rather than structure is put in the foreground, although the fact that some morphology is essential is not overlooked. Common names are chosen in preference to scientific.

Chapter I discusses the fundamental differences between lifeless and living things from a physiological point of view and this leads directly to a discussion of the composition of each in chapter II, which is by no means technical. Formulæ and symbols are avoided as much as seems compatible with an elementary understanding of the subject. The following chapters are given to a discussion of cells and osmosis, adaptation of plants, to perform nutritive and reproductive functions, propagation, relation of plants to human beings, and classification. Each chapter is replete with topics well adapted to stimulate thought and originality on the part of student and teacher.

In discussing the struggle for existence it appears that one important element is overlooked, viz: climatic conditions. In section 133 it seems that an erroneous idea is given in saying that a crop rotation of corn and a nitrogen-fixing plant will increase soil fertility. Crop rotation alone cannot keep the necessary elements in the soil.

These sections dealing with bacteria, moulds and the larger fungi are especially useful in that they recognize good as well as bad fungi.

The venerable Darwin occupies one page—a feature which is commendable. In fact we might prefer a half-tone of Asa Gray or some other well-known botanist to the plow and harrow figure in the chapter on plant propagation. High school teachers will doubtless find it a valuable book either for suggestion or as a text to be used in class.

S. H. S.

SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the February, June, and October issues of this journal the name and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. Names are dropped when they become a year old.

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